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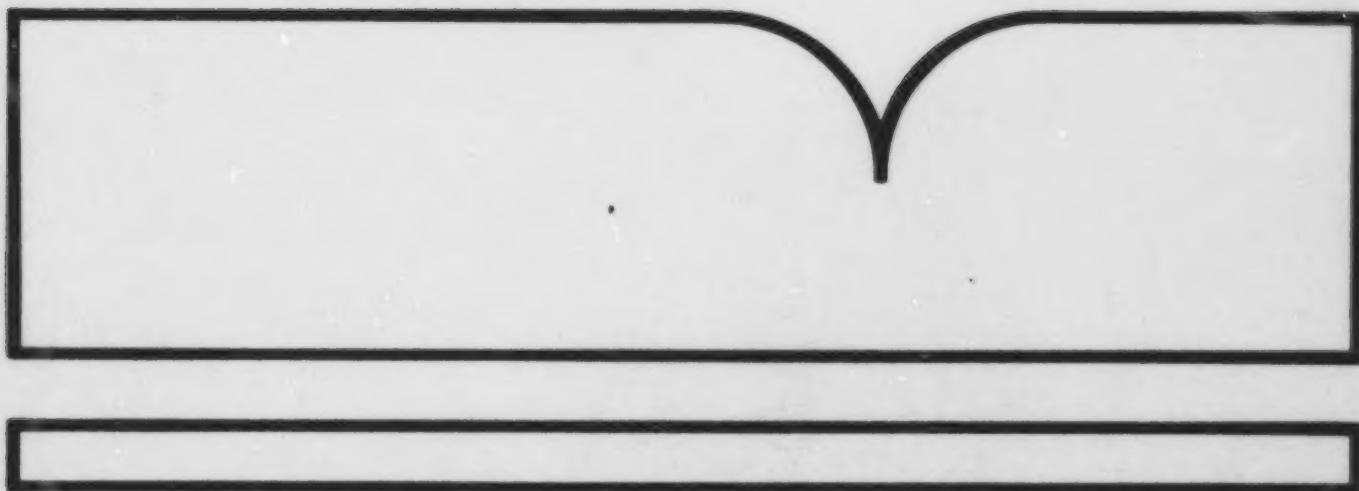
Summary of Indoor Air  
Quality Research Through 1984

Research Triangle Inst.  
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Prepared for

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A SUMMARY OF INDOOR AIR QUALITY RESEARCH  
THROUGH 1984

by

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| 16. ABSTRACT<br>The report reviews indoor air quality research from 1980 through December 1984. It is also a compilation of two documents that review relevant literature on the subject and summarize the efforts of leading research scientists. The first effort involved: (1) a review of journal articles, symposium presentations, and bibliographic reports from 1980 through 1983; (2) a list of contacts with approximately 30 prominent researchers in the indoor air quality field; and (3) a list of significant articles that appeared prior to 1980. The second effort updated the initial literature review to January 1985. Again, articles, symposium proceedings, and reports were screened in developing the update report. The vast majority of material found in the two reports, "Review of Recent Research in Indoor Air Quality" (EPA-600/2-84-099) and "Update of Indoor Air Quality Bibliography" (draft), has been retained in this document. This report integrates the material from the two reports, following the organization of the earlier. |                       |                                                  |  |                                                                 |     |
| 17. KEY WORDS AND DOCUMENT ANALYSIS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |                                                  |  |                                                                 |     |
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| Pollution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Mathematical Models   | Pollution Control                                |  | 13B                                                             | 12A |
| Atmospheric Contamination Control                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Residential Buildings | Stationary Sources                               |  |                                                                 |     |
| Research                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Smoking               | Indoor Air                                       |  | 06K                                                             | 13M |
| Formaldehyde                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Odors                 |                                                  |  | 14F                                                             | 21B |
| Radon                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Wood                  |                                                  |  | 07C                                                             | 06P |
| Ventilation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Natural Gas           |                                                  |  | 07B                                                             | 11L |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                       |                                                  |  |                                                                 | 21D |
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## ABSTRACT

This report reviews indoor air quality research with a focus on the period from 1980 through December 1984. It is also a compilation of two separate documents that review relevant literature on the subject and summarize the efforts of leading research scientists. The first effort involved 1) review of journal articles, symposium presentations and bibliographic reports from 1980 through 1983, 2) presentation of contacts with approximately 30 prominent researchers in the indoor air quality field and, 3) presentation of significant articles that appeared prior to 1980. In a second task for the Air and Energy Engineering Research Laboratory, The Research Triangle Institute updated the initial literature review to January 1985. Again articles, symposium proceedings and reports were screened in developing the update report.

The vast majority of the material found in the two reports "Review of Recent Research in Indoor Air Quality", EPA-600/2-84-009, and "Update of Indoor Air Quality Bibliography" (draft) has been retained in this document. This report integrates the material from the two reports and follows the organization of the earlier report.

In Section 4 the bibliographic citations are presented chronologically, i.e., the annotated bibliography precedes the updated bibliography. Discussion material for each section has been retained and is useful in identifying the limitations or deficiencies in the material presented.

The report was submitted in fulfillment of Contract No. 68-02-3992, Task 45, by Research Triangle Institute under sponsorship of the U.S. Environmental Protection Agency.

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# LIST OF ABBREVIATIONS

|         |                                                                               |
|---------|-------------------------------------------------------------------------------|
| AEC     | Atomic Energy Commission                                                      |
| AGA     | American Gas Association                                                      |
| APCA    | Air Pollution Control Association                                             |
| AASHRAE | American Society of Heating, Refrigeration, and Air<br>Conditioning Engineers |
| BPA     | Bonneville Power Authority                                                    |
| CDC     | Center for Disease Control                                                    |
| CPSC    | Consumer Product Safety Commission                                            |
| DOC     | U.S. Department of Commerce                                                   |
| DOE     | U.S. Department of Energy                                                     |
| EPA     | U.S. Environmental Protection Agency                                          |
| EPRI    | Electric Power Research Institute                                             |
| FDA     | Federal Drug Administration                                                   |
| GRI     | Gas Research Institute                                                        |
| HERL    | Health Effects Research Laboratory (EPA)                                      |
| IAQ     | Indoor Air Quality                                                            |
| IITRI   | Illinois Institute of Technology, Research Institute                          |
| JAPCA   | Journal of the Air Pollution Control Association                              |
| LBERI   | Lovelace Biological and Environmental Research Institute                      |
| LBL     | Lawrence Berkeley Laboratory                                                  |
| NAS     | National Academy of Sciences                                                  |
| NBS     | National Bureau of Standards (DOC)                                            |
| NCI     | National Cancer Institute                                                     |
| NHLBI   | National Heart, Lung, and Blood Institute                                     |
| NIEHS   | National Institute of Environmental Health Sciences                           |
| NIH     | National Institute of Health                                                  |
| NIOSH   | National Institute of Occupational Safety and Health                          |
| NYERDA  | New York Energy Research and Development Administration                       |
| ORNL    | Oak Ridge National Laboratories                                               |
| OSHA    | Occupational Safety and Health Administration                                 |
| PAH     | Polynuclear Aromatic Hydrocarbons                                             |
| PCB     | Polychlorinated Biphenyls                                                     |
| PHS     | U.S. Public Health Service                                                    |
| RTI     | Research Triangle Institute                                                   |
| SCBR    | Swedish Council for Building Research                                         |
| SERI    | Solar Energy Research Institute                                               |
| WHO     | World Health Organization                                                     |



## 1.0 INTRODUCTION

Indoor air quality is recognized as a significant factor affecting the well-being of the average American. In recent years, energy conservation practices such as weatherizing buildings and the greater use of unvented combustion (heating) devices have apparently increased indoor concentrations of hazardous air pollutants. Thus, the identification and evaluation of sources of indoor air pollution and their control has increasingly received attention from numerous Federal and State agencies concerned with health and environmental protection.

The objective of this report is to summarize indoor air quality research for the period 1980-1984. This was done by contacting prominent researchers in the field, summarizing their efforts and capabilities, and by reviewing published articles and reports. The report is intended to assist the indoor air quality research community in assessing the content and quality of its recent research efforts, to highlight milestone indoor air quality studies or symposia and to identify research facilities available to the user community. This information should serve to enhance coordination of government and private research efforts.

Two separate efforts were made by RTI to review relevant literature and publications. From October 1983 through February 1984 RTI developed an annotated bibliography, interviewed prominent researchers in the field, and provided a list of earlier citations that are important to the indoor air quality field. Then in early 1985 RTI extended the bibliographic review period from October 1983 to January 1985. Both reviews are found in Section 4 of this report and are consistent in organization, using a common outline.

Section 2.0, Conclusions and Recommendations, provides a short discussion of the quality and apparent deficiencies of the reviewed data base of articles, reports, and books. Section 3.0, Results and Discussion, contains an overview of indoor air quality research efforts and special capabilities. Section 4.0 presents an annotated bibliography and a follow up bibliography arranged by subject and Section 5.0 presents a list of unannotated citations similarly arranged. Section 6.0 documents telephone contacts with researchers engaged in studies of indoor air quality.

## 2.0 CONCLUSIONS AND RECOMMENDATIONS

The review of literature covering the period 1980-1983 (Section 4.2) and the telephone survey of prominent investigators (Section 6.0) indicated that the greatest share of indoor air quality research was directed toward the characterization and measurement of a limited number indoor pollutants. Within this area many studies sought to establish an average concentration level of a pollutant or the relationship of indoor concentrations to outdoor pollutant levels.

A small, but significant, body of research provided preliminary information on source types and emissions. Emphasis was directed toward the characterization of sources of formaldehyde and home combustion sources. Control and mitigation of indoor air quality problems generally emphasized the use of ventilation techniques.

Mathematical modeling of indoor air concentrations has been attempted and the results indicate some success based on comparisons with pollutant monitoring results.

As with the initial bibliography, articles from October 1983 through December 1984 dealing with the characterization and measurement of indoor air pollutants dominate the literature. Radon and radon daughters have continued to be an important indoor air quality problem receiving attention. Combustion sources and gaseous pollutants are well represented in the bibliography. In the area of "Control Methods," ventilation studies dominate, although air purification studies are also found. A growing body of information is found on the relationship between indoor air pollutants and health. Smoking is by far the single biggest concern, and the whole field of indoor exposure is receiving increased attention.

The modeling of indoor air quality is becoming more sophisticated as scientists and engineers give it increased attention. Recent articles have provided more complex and comprehensive models for assessing indoor air quality.

Several other trends may be seen from this bibliographic update. There has been some attention given to developing emission rate data. Increasingly, studies are looking at the total exposure of individuals to both indoor and outdoor pollutants. The regulatory agencies have only begun to address the problems and potential impacts of indoor pollutants.



Further study of control options other than ventilation--for example, source modification to reduce emission rates or air purifying methods to reduce pollutant levels--should also be pursued. The development of mathematical models should continue as they may be a cost-effective mechanism for assessing the total health significance of indoor air quality. These models should be expanded to consider a wider range of pollutants as well as integrated with laboratory and field measurements of input parameters. This development will only occur when expanded monitoring data becomes available, leading to a more complete characterization of the indoor environment.

### 3.0 RESULTS AND DISCUSSION

Our attempt to define the state-of-the-art in indoor air pollution research used two approaches: (1) a review of recent literature and, (2) telephone contacts to prominent investigators. The literature review covers several sources including searches of computer files, the citation lists in the NAS Indoor Pollutants document, in Indoor Air Pollution by Wadden and Scheff, and in review articles such as "Indoor Air Pollution: A Public Health Perspective" by Spengler and Sexton, (1983) and in the 1984 Stockholm International Symposium on Indoor Air Pollution. Manual searches of several journals that frequently publish indoor air quality research provided articles current through December, 1983. Primary emphasis was placed on peer-reviewed journal articles rather than government reports of symposia presentations. Roughly 30 prominent investigating laboratories were contacted to assess the extent of on-going research in indoor air quality. Specific inquiries as to the nature of the work, the measurements performed, funding levels, sponsor, and special facilities provided an up-to-date inventory.

In the Overview (Section 3.1), two tables summarize the information gained from telephone contacts and our review of recent (1980-1983) literature. The Annotated Bibliography (Section 4.2) reviews the same recent literature and provides capsule summaries of the literature. The Update Bibliography augments the annotated bibliography by extending the literature review through 1984. Under Additional Citations (Section 5.0), significant early literature (prior to 1980) and a few recent articles for which there was insufficient time to annotate, are listed. Both these bibliographies are arranged by subject.

#### 3.1 OVERVIEW: SUMMARY TABLES

Table 3-1 is a summary of activities in indoor air quality research providing the sponsor, investigating organization, description of the subject area, broad classification of the work, and the pollutants measured. Recent articles (1980-1983) and telephone contact summaries formed the basis of this table. The format of the table follows C. B. Meyer et al.'s Inventory of Current Indoor Air Quality-Related Research (EPA-600/7-81-119). In general, this report is supplementary and updates the Meyer et al. report.

Table 3-2 summarizes the special capabilities of various organizations for conducting indoor air quality research. The table is also based on recent articles and telephone contact summaries. Tables 3-1 and 3-2 are cross-referenced by using the "Inventory number" for each Table 3-1 entry. In addition, each Table 3-2 entry is cross-referenced to a "hard" reference, within either the Annotated Bibliography or the Contact Summaries.

TABLE 3-1 SUMMARY OF ACTIVITIES IN INDOOR AIR QUALITY RESEARCH

| Inv. No. | Sponsor | Investigator & organization <sup>a</sup> (cross reference)                                                 | Subject                                                                             | Study Area |                 |                |                 |                    |                  |       |                 |    |                 | Pollutant |     |          |               |      |       |            |                |  |  |
|----------|---------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|-----------------|-----------|-----|----------|---------------|------|-------|------------|----------------|--|--|
|          |         |                                                                                                            |                                                                                     | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | NH <sub>3</sub> | Asbestos  | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutant |  |  |
| 1        | DOE     | Craig Hollowell, Robert Miksch, LBL (B46)                                                                  | Sources of indoor organic compounds                                                 | X          |                 |                |                 |                    | X                | X     |                 |    |                 | X         |     |          |               |      |       |            |                |  |  |
| 2        | DOE     | Robert Miksch, Craig Hollowell, and H. Schmidt, LBL (B52)                                                  | Trace organics in offices                                                           | X          |                 |                |                 | X                  | X                |       |                 |    |                 |           |     |          |               |      |       |            |                |  |  |
| 3        | DOE     | R. Geisling, M. Tashima, V. Girman, and R. Miksch, LBL; S. Kappasfort, U. of California (Berkeley) (B44)   | Passive formaldehyde sampler, NaHSO <sub>3</sub> soaked glass filters               | X          |                 |                |                 |                    |                  |       |                 |    |                 |           | X   |          |               |      |       |            |                |  |  |
| 4        | DOE     | G. Traynor, D. Anthon, and C. Hollowell, LBL (B61)                                                         | Technique for determining gas range pollutants                                      | X          |                 |                |                 | X                  | X                |       | X               | X  | X               |           | X   |          |               |      |       |            |                |  |  |
| 5        | DOE     | J. Girman, M. Apté, G. Traynor, J. Allen, and C. Hollowell, LBL (B74)                                      | Pollutant rates from combustion and smoking                                         | X          |                 |                |                 | X                  | X                |       |                 |    |                 |           |     |          |               |      |       |            |                |  |  |
| 6        | DOE     | G. Traynor, M. Apté, J. Dillworth, C. Hollowell, and E. Sterling, LBL (B82)                                | Effects of residential ventilation on gas-range emissions                           | X          |                 |                |                 | X                  | X                |       | X               | X  | X               |           | X   |          |               |      |       |            |                |  |  |
| 7        | DOE     | W. Nazaroff, M. Boegel, C. Hollowell, and G. Roseme, LBL (B89)                                             | Ventilation for radon                                                               | X          |                 |                |                 | X                  | X                | X     |                 |    |                 |           |     |          |               |      |       |            |                |  |  |
| 8        | DOE     | I. Turiel, C. Hollowell, R. Miksch, J. Rudy, and R. Young, LBL; M. Coye, S. F. General Hospital (B109)     | Reduced ventilation effects in offices                                              | X          |                 |                |                 | X                  | X                |       | X               | X  | X               |           | X   | X        |               | X    |       |            |                |  |  |
| 9        | DOE     | C. Hollowell, J. Berk, M. Boegel, R. Miksch, W. Nazaroff, and G. Traynor, LBL (B97)                        | Ventilation and indoor air quality                                                  |            |                 |                |                 | X                  | X                |       | X               | X  | X               |           | X   | X        |               |      |       |            |                |  |  |
| 10       | DOE     | J. Offerman, C. Hollowell, W. Nazaroff, G. Roseme, LBL; J. Blizzone, NY State ERDA in Rochester, NY (B105) | Low ventilation and air quality                                                     | X          |                 |                |                 | X                  | X                |       | X               | X  | X               |           |     |          |               |      |       |            |                |  |  |
| 11       | DOE     | D. Griemrud, LBL (C1)                                                                                      | Passive instrumentation for formaldehyde, H <sub>2</sub> O, CO, and NO <sub>2</sub> |            |                 |                |                 | X                  | X                |       | X               | X  | X               |           |     |          |               |      |       |            |                |  |  |

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TABLE 3-1 (continued)

| Inv. No. | Sponsor           | Investigator & organization (cross reference) <sup>a</sup>                                                 | Subject                                                                    | Study Area |                 |                |                 |                    |                  |       |                 |    |      | Pollutant |     |          |               |      |       |            |                 |  |  |
|----------|-------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|-----------|-----|----------|---------------|------|-------|------------|-----------------|--|--|
|          |                   |                                                                                                            |                                                                            | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO | Asbestos  | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutants |  |  |
| 12       | DOE               | D. Grinstead, LBL (C2)                                                                                     | Building materials emissions                                               | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          |               |      |       |            |                 |  |  |
| 13       | DOE, EPRI and GRI | D. Grinstead, LBL (C3)                                                                                     | Numerical data base for IAQ                                                |            |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                 |  |  |
| 14       | DOE/DOER and EPA  | D. Grinstead, LBL (C4)                                                                                     | Radon and progeny: national distribution                                   |            | X               |                |                 |                    | X                | X     |                 |    |      |           |     |          |               |      |       |            |                 |  |  |
| 15       | DOE/HEAD          | Gregory Traynor, J. Allen, Michael Apte, J. Dillworth, J. Girman, C. Hollowell, and J. Koince, LBL (B83)   | Indoor air pollution from kerosene heaters, wood stoves, and wood furnaces | X          |                 |                |                 |                    | X                | X     | X               | X  | X    | X         |     |          |               |      |       |            |                 |  |  |
| 16       | DOE               | M. Cain and B. Leederer, Yale University (B94)                                                             | Ventilation requirements during smoking and non-smoking                    | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          | X             |      |       |            |                 |  |  |
| 17       | DOE               | M. Cain, B. Leederer, R. Isseroff, L. Berglund, R. Huey, E. Lipsitt, and D. Perlman, Yale University (B93) | Control of odors--ventilation requirements                                 | X          |                 |                |                 |                    | X                | X     | X               |    |      |           |     |          | X             | X    |       |            |                 |  |  |
| 18       | DOE               | A. Persily, Princeton (B106)                                                                               | Heat exchanger evaluation                                                  |            |                 |                |                 |                    | X                |       |                 |    |      |           |     |          |               |      |       |            |                 |  |  |
| 19       | DOE               | Thomas Hernandez, Princeton; James Ring, Hamilton College (B59)                                            | Two-chamber radon model                                                    | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          |               |      |       |            |                 |  |  |
| 20       | DOE               | Brian Mokler, Brian Wong, and Michael Snow, LBERI (B68)                                                    | Respirable particulate from pressurized consumer products                  |            |                 |                |                 |                    | X                |       |                 |    |      |           |     | X        |               |      |       |            |                 |  |  |
| 21       | DOE               | Brian Mokler, Brian Wong, and Michael Snow, LBERI (B69)                                                    | Experimental conditions effects on resp. particles from consumer products  |            |                 |                |                 |                    | X                |       |                 |    |      |           |     | X        |               |      |       |            |                 |  |  |
| 22       | DOE and CPSC      | F. Matthews, A. Hawthorne, T. C. Howell, C. Heicaffe, and R. Gannage, ORNL (B50)                           | Formaldehyde monitoring methods evaluation                                 | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                 |  |  |
| 23       | DOE               | F. Matthews, ORNL (C9)                                                                                     | IAQ of unoccupied homes                                                    | X          | X               |                |                 |                    | X                | X     |                 |    |      |           |     |          |               |      |       |            |                 |  |  |
| 24       | DOE               | A. Hawthorne, ORNL (C10)                                                                                   | Radon and formaldehyde in energy conserving homes                          | X          | X               |                |                 |                    | X                | X     |                 |    |      |           |     |          |               |      |       |            |                 |  |  |
| 25       | DOE               | Russell Bletz, and Edgar Cole, Brookhaven Nat. Lab (B96)                                                   | Air infiltration measurement technique                                     | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          |               |      |       |            |                 |  |  |

See footnote at end of table.

(cont. Inued)



TABLE 3-1 (continued)

| Inv. No. | Sponsor | Investigator & organization <sup>a</sup><br>(cross reference)                                    | Subject                                                | Study Area |                 |                |                 |                    |                  |       |                 |    |      | Pollutant |     |          |               |      |       |            |                |  |  |
|----------|---------|--------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|-----------|-----|----------|---------------|------|-------|------------|----------------|--|--|
|          |         |                                                                                                  |                                                        | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCOM | Asbestos  | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutant |  |  |
| 26       | DOE     | E. Knutson, Dept. of Energy (C15)                                                                | Assessment of radon and other contaminants             | X          | X               |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 27       | DOE     | J. Bundo, Argonne (C16)                                                                          | Single home radon                                      | X          |                 |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 28       | DOE     | B. Davidson, Carnegie Mellon U. (C17)                                                            | Energy monitoring of houses                            | X          |                 |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 29       | EPA     | Kathryn MacLeod, EPA/NERL (B49)                                                                  | PCBs in indoor air                                     | X          | X               |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 30       | EPA     | M. Jackson and R. Lewis, EPA/NERL (B67)                                                          | Pest control strips                                    | X          |                 |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 31       | EPA     | R. Stacy, and J. Green, EPA/NERL (B130)                                                          | Pollutant effects on pulmonary function                |            |                 | X              |                 |                    |                  |       |                 | X  |      |           |     |          |               |      |       |            |                |  |  |
| 32       | EPA     | Ronald Bruno, EPA/URP (B57)                                                                      | Radon sources in houses                                | X          |                 |                |                 | X                  |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 33       | EPA     | F. Black, EPA/ESRL (C19)                                                                         | Auto emissions testing                                 | X          |                 |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 34       | EPA     | L. Wallace, EPA                                                                                  | CO in an underground office                            | X          |                 |                |                 | X                  |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 35       | EPA     | L. Wallace, EPA; R. Zweldinger, M. Erikson, S. Cooper, D. Whitaker, and E. Pettizzari, RTI (B30) | Volatile organics in air and water                     | X          | X               |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 36       | EPA     | Edo Pettizzari, Research Triangle Institute (RTI) (C20)                                          | Personal exposure to 21 volatile organics              | X          | X               |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 37       | EPA     | Edo Pettizzari, RTI (C21)                                                                        | Personal exposure to halogenated organics              | X          |                 |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 38       | EPA     | Edo Pettizzari, RTI (C22)                                                                        | Total exposure and assessment methodology              | X          |                 |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 39       | EPA     | Fy Hartwell, RTI (C23)                                                                           | Study of personal CO exposure                          | X          |                 |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 40       | EPA     | Linda Sheidon, RTI (C24)                                                                         | Monitoring of organics and inorganics around buildings | X          |                 |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 41       | EPA     | K. Bally, L. Hanrahan, and M. Woodbury, Wisc. Div. of Health; M. Kanarek, U. of Wisconsin (B41)  | Nonoccupational formaldehyde exposure                  | X          |                 |                |                 |                    |                  |       | X               |    |      |           |     |          |               |      |       |            |                |  |  |

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

| Inv. No. | Sponsor     | Investigator & organization <sup>a</sup> (cross reference)                                            | Subject                                                 | Study Area |                 |                |                 |                    |                  |       |                 |    |      |          | Pollutant |          |               |      |       |            |                 |  |  |  |
|----------|-------------|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|----------|-----------|----------|---------------|------|-------|------------|-----------------|--|--|--|
|          |             |                                                                                                       |                                                         | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO | Asbestos | TSP       | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutants |  |  |  |
| 42       | EPA         | A. Eckmann, State Lab. of Hygiene; K. Bally, L. Hanrahan, and H. Anderson, Misc. Div. of Health (B42) | Comparison of formaldehyde determination methods        | X          | X               |                |                 |                    |                  |       |                 |    |      | X        |           |          |               |      |       |            |                 |  |  |  |
| 43       | EPA         | W. Hinds, S. Rudnick, E. Maher, and M. First, Harvard School of Public Health (B88)                   | Control of radon by air treatment devices               | X          |                 |                |                 | X                  | X                | X     |                 |    |      |          |           |          |               |      |       |            |                 |  |  |  |
| 44       | EPA         | T. Tosteson, J. Spengler, and R. Vokac, Harvard School of Public Health (B29)                         | Metal content of particulates from personal monitoring  | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |           |          |               |      |       |            | X               |  |  |  |
| 45       | EPA         | P. Ryan, J. Spengler, and R. Letz, Harvard School of Public Health (B79)                              | Kerosene heater pollution; monitoring and modeling      | X          |                 |                |                 | X                  | X                |       | X               |    |      |          |           |          |               |      |       |            |                 |  |  |  |
| 46       | EPA         | M. Ott, EPA and D. Flachsbart, University of Hawaii (B26)                                             | Personal monitors for CO                                | X          |                 |                |                 | X                  | X                |       |                 | X  |      |          |           |          |               |      |       |            |                 |  |  |  |
| 47       | EPA         | R. Ziskind, and K. Fife, Science Applications; D. Hage, U.S. EPA (B31)                                | CO monitoring in the general population                 | X          |                 |                |                 | X                  | X                |       |                 | X  |      |          |           |          |               |      |       |            |                 |  |  |  |
| 48       | EPA and NIH | M. Iebowitz, University of Arizona (E26)                                                              | Pollutants, allergens, and resp. disease                | X          |                 | X              |                 | X                  | X                |       |                 | X  |      |          | X         | X        | X             | X    | X     | X          |                 |  |  |  |
| 49       | EPA         | H. Pritchard, T. Gettell, C. Hess, C. Weiffenbach, and D. Hyberg, U. of Texas, S. of P.H. (B66)       | Sampling comparison for radon                           | X          |                 |                |                 |                    |                  | X     |                 |    |      |          |           |          |               |      |       |            |                 |  |  |  |
| 50       | EPA         | M. Esman, H. Corn, Y. Hamad, D. Whittier, and H. Kulsko, U. of Pittsburgh (B10)                       | Exposure to dust and fiber in man-made fiber facilities | X          |                 |                |                 |                    | X                |       |                 |    |      | X        | X         |          |               |      |       |            |                 |  |  |  |
| 51       | EPA         | Roy Neulicht, Del Green Assoc.; John Core, NEA, Inc. (B77)                                            | Wood burning appliances and indoor air quality          | X          |                 |                |                 |                    | X                |       |                 |    |      |          | X         | X        |               |      |       |            | X               |  |  |  |
| 52       | AEC and EPA | M. Culot, Centro Nuclear de Mexico; R. Schlager, U. of Pittsburgh; H. Olson, Colorado State U. (B11)  | Increased gamma fields from radon barrier on concrete   | X          |                 |                |                 |                    | X                |       |                 |    |      |          |           |          |               |      |       |            |                 |  |  |  |

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

| Inv. No. | Sponsor        | Investigator & organization (cross reference) <sup>a</sup>                                                | Subject                                                              | Study Area |                 |                |                 |                    |                  |       |                 |    |      | Pollutant |     |          |               |      |       |            |                |  |  |
|----------|----------------|-----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|-----------|-----|----------|---------------|------|-------|------------|----------------|--|--|
|          |                |                                                                                                           |                                                                      | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO | Asbestos  | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutant |  |  |
| 53       | NIOSH          | M. Selway, R. Allan, R. Madden, U. of Illinois, Chicago (B37)                                             | Ozone from photocopying machines                                     | X          |                 |                |                 | X                  |                  |       |                 |    |      |           |     |          |               | X    |       |            |                |  |  |
| 54       | NIOSH          | M. Hedley, Monsanto (C27)                                                                                 | Exposure assessment of formaldehyde production                       | X          |                 |                |                 | X                  | X                |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 55       | NIOSH          | R. Mitchell, Battelle Columbus (C28)                                                                      | Worker exposure in electronics components industry                   | X          |                 |                |                 | X                  | X                | X     | X               | X  | X    | X         | X   | X        |               |      |       | X          |                |  |  |
| 56       | NIOSH and OSHA | R. Young, R. Rinsky, and P. Infante, NIOSH; J. Wagoner, OSHA (B71)                                        | Benzene in consumer products                                         | X          |                 | X              |                 |                    | X                |       |                 |    |      |           |     |          | X             |      |       |            |                |  |  |
| 57       | NIEHS          | H. Ozkaynak, Harvard University; P. Ryan, G. Allen, and W. Turner, Harvard School of Public Health (B134) | Indoor air modeling: compartmental approach                          | X          |                 |                |                 |                    | X                | X     |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 58       | NIEHS          | C. Ju, NY State Health Dept.; J. Spengler, Harvard School of P.H. (B1)                                    | Respirable particles by room                                         | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     | X        |               |      |       |            |                |  |  |
| 59       | NIEHS          | J. Spengler, D. Dockery, M. Turner, J. Wolfson, and B. Ferris, Harvard School of P.H. (B3)                | Long-term measurement of respirable particles and sulfates           | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     | X        |               |      |       |            |                |  |  |
| 60       | NIEHS          | S. Colome, J. Spengler, and S. McCarthy, Harvard School of P.H. (B16)                                     | Inorganics comparison indoor-outdoor                                 | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     | X        |               |      |       | X          |                |  |  |
| 61       | NIEHS          | D. Dockery and J. Spengler, Harvard School of P.H. (B24)                                                  | Exposure to particulates and sulfates                                | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          |               |      |       | X          |                |  |  |
| 62       | NIEHS and EPA  | J. Spengler, Harvard School of Public Health (C29)                                                        | SO <sub>2</sub> & particulate health effects                         |            | X               |                |                 |                    | X                | X     | X               | X  |      |           |     | X        |               |      |       | X          |                |  |  |
| 63       | NIEHS and EPA  | J. Spengler, Harvard School of Public Health (C30)                                                        | SO <sub>2</sub> & particulate health effects (continuation of above) | X          | X               | X              |                 |                    | X                | X     | X               | X  | X    | X         | X   | X        |               |      |       |            |                |  |  |
| 64       | NIEHS          | K. Helting, G. Comstock, M. Meyer, and H. Tuckman, Johns Hopkins U. (B121)                                | Tobacco smoke and gas appliance respiratory effects on nonsmokers    |            |                 | X              |                 |                    |                  |       |                 |    |      |           |     |          |               | X    |       |            |                |  |  |

See footnote at end of table.

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TABLE 3-1 (continued)

| Inv. No. | Sponsor                 | Investigator & organization <sup>a</sup><br>(cross reference)                                                         | Subject                                                     | Study Area |                 |                |                 |                    | Pollutant        |       |                 |    |      |          |     |          |               |      |       |            |                |
|----------|-------------------------|-----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|----------|-----|----------|---------------|------|-------|------------|----------------|
|          |                         |                                                                                                                       |                                                             | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO | Asbestos | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutant |
| 65       | NIEHS and NIDHD         | M. Scheiner, Harvard Medical School; S. Weiss, Beth Israel Hospital; B. Murawski, Brigham and Women's Hospital (B12B) | Urea formaldehyde insulation health effects in homes        |            |                 | X              | X               |                    |                  |       |                 |    |      | X        |     |          |               |      |       |            |                |
| 66       | NIEHS                   | B. Leaderer, J. B. Pierce Foundation Lab (Yale) (C32)                                                                 | Side stream tobacco smoke                                   |            |                 |                |                 | X                  |                  |       |                 |    |      |          |     |          |               |      |       |            |                |
| 67       | NIEHS                   | A. Stolwijk, J. B. Pierce Lab (C33)                                                                                   | Human responses to thermal stress pollutants                | X          |                 | X              | X               |                    | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 68       | NIEHS                   | M. Cain and B. Leaderer, J. B. Pierce Lab (C34)                                                                       | Ventilation filtration for tobacco smoke                    |            |                 |                |                 | X                  | X                |       |                 |    |      |          |     | X        |               |      |       |            |                |
| 69       | NIEHS                   | B. Leaderer, J. B. Pierce Lab, Yale U. (C35)                                                                          | Decay of SO <sub>2</sub> and NO <sub>2</sub> on surfaces    |            |                 |                |                 | X                  |                  | X     |                 |    |      |          |     |          |               |      |       |            |                |
| 70       | NIEHS                   | B. Leaderer, J. B. Pierce Lab, Yale U. (C36)                                                                          | Comparison of portable with stationary particulate monitors | X          |                 |                |                 |                    | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 71       | NIEHS                   | M. Cain, J. B. Pierce Lab (C37)                                                                                       | Irritation effects of formaldehyde                          |            |                 |                |                 |                    |                  |       | X               |    |      |          |     |          |               |      |       |            |                |
| 72       | NIEHS                   | V. Nicholson, E. Swoszowski, A. Buhl, J. Todaro, and A. Adams, Mt. Sinai School of Medicine (B8)                      | Asbestos in schools                                         | X          |                 |                |                 |                    | X                |       |                 |    |      | X        |     |          |               |      |       |            |                |
| 73       | NIEHS                   | B. Jaeger, NYU Med. Center (B33)                                                                                      | CO in homes/cars                                            |            |                 | X              |                 |                    |                  |       |                 |    | X    |          |     |          |               |      |       |            |                |
| 74       | CPSC                    | A. Hawthorne, ORNL (C11)                                                                                              | Volatile organics in homes                                  | X          | X               |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |                |
| 75       | CPSC, EPA, and DOE/NIER | D. Griensrud, IUL (C5)                                                                                                | Appliance emissions                                         | X          |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |                |
| 76       | CPSC                    | K. Gupta, A. Ulsamer, and P. Preiss, CPSC (B120)                                                                      | Formaldehyde: sources, and toxicity                         |            |                 |                |                 |                    |                  | X     | X               | X  | X    |          |     |          |               |      |       |            |                |
| 77       | CPSC and DOE            | A. Hawthorne, ORNL (C12)                                                                                              | IAQ of E. Tennessee homes                                   | X          |                 |                |                 |                    | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 78       | CPSC                    | T. Matthews, ORNL (C13)                                                                                               | Characterization of formaldehyde sources                    |            |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |                |
| 79       | CPSC and DOE            | J. Pickrell, B. Mahler, L. Griffin, C. Hinds, and A. Bathija, IBERI (B70)                                             | Formaldehyde from consumer products                         | X          | X               |                |                 |                    | X                |       |                 |    |      |          |     |          |               |      |       |            |                |

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

| Inv. No. | Sponsor                                                             | Investigator & organization <sup>a</sup> (cross reference)                                                             | Subject                                                      | Study Area |                 |                |                 |                    |                  |       |                 |    |      | Pollutant |     |          |               |       |            |                |  |  |  |
|----------|---------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|-----------|-----|----------|---------------|-------|------------|----------------|--|--|--|
|          |                                                                     |                                                                                                                        |                                                              | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO | Asbestos  | TSP | Organics | Tobacco Smoke | Ozone | Biological | Multipollutant |  |  |  |
| 00       | U.S. Air Force                                                      | J. Livingston and C. Jones, Aer. Med. Res. Lab (B40)                                                                   | Chlordane from termite treatment                             | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          |               |       |            |                |  |  |  |
| 01       | U.S. Air Force                                                      | J. Lodge, RII (C25)                                                                                                    | Analysis of termiticide air samples                          | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |       |            |                |  |  |  |
| 02       | NCI                                                                 | E. Sansone and M. Stein, Fredk. Cancer Research Center (B114)                                                          | Redispersion of surface contaminants                         |            |                 |                |                 | X                  | X                |       |                 |    |      |           |     |          |               |       |            |                |  |  |  |
| 03       | HLBI                                                                | R. Binder, C. Mitchell, H. Hovelin, and A. Boudry, Yale University (B117)                                              | Importance of indoor air pollution exposure                  | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          |               |       |            |                |  |  |  |
| 04       | HLBI                                                                | M. Lebowitz, B. Arnet, and R. Knudson, HLBI (B125)                                                                     | Passive smoking effects on pulmonary function in children    |            |                 | X              | X               |                    |                  |       |                 |    |      |           |     |          |               |       |            |                |  |  |  |
| 05       | CDC, Colorado Dept. of Health, and Tri-County District Health Dept. | K. Kreiss, CDC, M. Genzeler, Col. Dept. of Health, K. Conright and A. Scherer, Tri-County District Health Dept. (B124) | Carpet shampoo respiratory irritation                        | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |       |            |                |  |  |  |
| 06       | MAS/MRC                                                             | T. Sterling, H. Blinich, S. Fraser U.; D. Kobayashi, Columbia U. (B6)                                                  | Tobacco smoke byproduct levels                               | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          | X             |       |            |                |  |  |  |
| 07       | MSF                                                                 | C. Davidson, Carnegie Mellon U. (C10)                                                                                  | Building design and other IAQ factors                        | X          |                 |                |                 | X                  | X                |       |                 |    |      |           |     |          | X             |       |            |                |  |  |  |
| 08       | SERI                                                                | M. Rogozen, Sciences Applications (Los Angeles) (B137)                                                                 | Radon from rockbed heat storage                              |            |                 |                |                 |                    | X                | X     |                 |    |      |           |     |          |               |       |            |                |  |  |  |
| 09       | HBS                                                                 | T. Kusuda, S. Silberstein, and P. McNall, HBS (B64)                                                                    | Modeling of radon in ventilated spaces                       |            |                 |                |                 | X                  | X                | X     |                 |    |      |           |     |          |               |       |            |                |  |  |  |
| 90       | HBS                                                                 | P. McNall, HBS (B103)                                                                                                  | Building ventilation measurements, predictions and standards | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          | X             |       |            |                |  |  |  |
| 91       | IVA                                                                 | R. Maxwell, IVA (C40)                                                                                                  | Radioactivity in non-slag homes                              | X          |                 |                |                 |                    | X                | X     |                 |    |      |           |     |          |               |       |            |                |  |  |  |
| 92       | IVA and EPA                                                         | R. Imhoff, IVA (C41)                                                                                                   | Woodstoves & IAQ                                             | X          |                 |                |                 |                    | X                |       |                 |    |      |           |     |          |               | X     |            |                |  |  |  |
| 93       | IVA and EPA                                                         | J. Harper, IVA (C42)                                                                                                   | Woodburning evaluation                                       | X          |                 |                |                 | X                  | X                |       |                 |    |      |           |     |          |               | X     |            |                |  |  |  |
| 94       | IVA and EPRI                                                        | A. Hawthorne, ORNL (C14)                                                                                               | IAQ related to energy conservation                           | X          |                 |                |                 | X                  | X                | X     |                 |    |      |           |     |          |               | X     |            |                |  |  |  |

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TABLE 3-1 (continued)

| Inv. No. | Sponsor                      | Investigator & organization (cross reference) <sup>a</sup>                                               | Subject                                                     | Study Area |                 |                |                 |                    |                  |       |                 |    |      | Pollutant |     |          |               |      |       |            |                |  |  |
|----------|------------------------------|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|-----------|-----|----------|---------------|------|-------|------------|----------------|--|--|
|          |                              |                                                                                                          |                                                             | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO | Asbestos  | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutant |  |  |
| 95       | ASHRAE                       | F. Jarvis, A. Dravnieks, and S. Gordon, IITRI (B47)                                                      | Organics, indoor-outdoor relationship                       | X          |                 |                |                 |                    |                  |       |                 |    |      | X         |     |          |               |      |       |            |                |  |  |
| 96       | ASHRAE                       | Yuen Wang, Harbor Branch Foundation Lab (Florida) (B55)                                                  | Effluents in college classroom                              | X          |                 |                |                 |                    |                  |       |                 |    |      | X         |     |          |               |      |       |            |                |  |  |
| 97       | ASHRAE                       | Garry Caffey, Texas Power and Light Co. (B92)                                                            | Residential air infiltration                                | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 98       | ASHRAE                       | J. Janssen, A. Pearson, and Y. Hill, Honeywell, Inc. (B99)                                               | Examination of Infiltration models                          |            |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 99       | GRI                          | James Cole, Thomas Zawacki, Robert Elkins, Jon Zimmer, and Robert MacRies, Inst. of Gas Technology (B95) | Application of an air infiltration model to homes           |            |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 100      | GRI                          | J. Spengler, Harvard S. of Public Health (C31)                                                           | Personal and total exposure assessment                      | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 101      | GRI                          | D. Moschandreas, IITRI (C43)                                                                             | Emissions from gas appl., kerosene, cigarettes              | X          |                 |                |                 | X                  | X                | X     | X               | X  | X    | X         |     |          |               |      |       |            |                |  |  |
| 102      | AGA                          | R. Coutant, E. Herryman, and A. Levy, Battelle Columbus (B73)                                            | NO <sub>2</sub> from ranges                                 | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 103      | EPRI                         | M. Hagda, Geomet (C48)                                                                                   | CO exposure                                                 | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 104      | EPRI                         | M. Hagda, Geomet (C49)                                                                                   | Energy, infiltration, and indoor air quality                | X          |                 |                |                 | X                  | X                | X     | X               | X  | X    | X         |     |          |               |      |       |            |                |  |  |
| 105      | EPRI                         | J. Yocum, TRC (C56)                                                                                      | Risk assessment evaluation                                  |            |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 106      | EPRI                         | K. McGill and D. Miller, Washburn U. (Kansas) (B76)                                                      | Exposure to organic particulates from wood heating          | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 107      | NY Lung Association          | Marc Halpern, City U. of NY (B17)                                                                        | Lead indoor/outdoor exposure relationships                  | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 108      | Chicago Lung Association     | Robert Allen and Richard Wadden, U. of Illinois School of Public Health (B12)                            | Indoor concentration of CO and O <sub>2</sub> in a hospital | X          |                 |                |                 |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 109      | Industrial Health Foundation | P. Gross, U. of Pittsburgh; J. Tuma and R. de Treville, Industrial Health Foundation (B119)              | Lungs of workers exposed to fiber glass                     |            |                 | X              | X               |                    |                  |       |                 |    |      |           |     |          |               |      |       |            |                |  |  |

See footnote at end of table.

(continued)


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TABLE 3-1 (continued)

| Inv. No. | Sponsor                                             | Investigator & organization <sup>a</sup> (cross reference)                    | Subject                                                           | Study Area |                 |                |                 |                    | Pollutant        |       |                 |    |      |          |     |          |               |      |       |            |                |
|----------|-----------------------------------------------------|-------------------------------------------------------------------------------|-------------------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|----------|-----|----------|---------------|------|-------|------------|----------------|
|          |                                                     |                                                                               |                                                                   | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO | Asbestos | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutant |
| 110      | Prince George's Envir. Coalition                    | J. Repace and A. Lowry, Naval Research Laboratory (B5)                        | Indoor air pollution, tobacco, Pub. Health                        | X          |                 |                | X               | X                  | X                |       |                 |    |      |          | X   |          |               |      |       |            |                |
| 111      | Minnesota State Planning Agency                     | M. Garry, L. Gatzman, R. Pleus, and D. Gray, Minnesota Dept. of Health (B43)  | Formaldehyde levels                                               | X          |                 | X              |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 112      | Andrew Mellon Foundation                            | F. Shafr, Cal. Inst. of Tech. (B90)                                           | Filtration of ozone and SO <sub>2</sub> from make up air          | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 113      | Northeast States for Coordinated Air Use Management | Barbara Beck and Joseph Brain, Harvard School of Public Health (B116)         | Pulmonary toxicity due to wood and coal stove combustion products |            |                 | X              | X               |                    |                  |       |                 |    |      |          | X   | X        |               |      |       |            |                |
| 114      | Bell State U.                                       | T. Godish, Bell State U. (B45)                                                | Formaldehyde sickness                                             | X          |                 | X              | X               |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |                |
| 115      | Cal. Inst. of Tech.                                 | F. Shafr, and K. Heltner, Cal. Inst. of Technology (B135)                     | Model of indoor/outdoor levels                                    | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 116      | U. of Cincinnati                                    | D. Sterling, S. Clark, and S. Bjornson, U. of Cinc. Medical Center (B11)      | Air control effects on Viable particle distribution               | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 117      | Drexel University                                   | L. Levin and P. Purdue, Drexel University (B126)                              | Health effects of energy conserving materials                     |            |                 | X              | X               |                    |                  |       |                 |    |      |          | X   | X        |               |      |       |            |                |
| 118      | U. of Illinois                                      | R. Madden, U. of I. School of Pub. Health (B51)                               | Indoor air research                                               | X          |                 |                |                 | X                  | X                |       |                 | X  | X    | X        | X   |          | X             |      |       |            |                |
| 119      | Indiana U. and Minnesota Dept. of Health            | Ingrid Ritchie, U. of Indiana; Laura Gatzman, Minnesota Dept. of Health (B78) | Kerosene heater pollution                                         | X          |                 |                |                 | X                  | X                |       |                 | X  | X    | X        | X   |          |               |      |       |            |                |
| 120      | Harvard S. of P.H.                                  | P. Bellin and J. Spengler, Harvard S. of P.H. (B14)                           | Indoor/outdoor CO at airport                                      | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 121      | Johns Hopkins                                       | C. Billings, J. Hopkins, and S. Vanderslice, Exxon Co. (B113)                 | Methods for control of indoor air quality                         |            |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 122      | U. of Maine                                         | C. Hess, C. Weiffenbach, and S. Norton, U. of Maine (B60)                     | Water and airborne radon in houses                                | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |

See footnote at end of table.

(continued)

TABLE 3-1 (continued)

| Inv. No. | Sponsor                     | Investigator & organization (cross reference) <sup>a</sup>                                                 | Subject                                                 | Study Area |                 |                |                 |                    | Pollutant        |       |                 |    |      |          |     |          |               |      |       |            |
|----------|-----------------------------|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|----------|-----|----------|---------------|------|-------|------------|
|          |                             |                                                                                                            |                                                         | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCDH | Asbestos | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological |
| 123      | U. of Pittsburgh            | J. Altona, B. Cohen, H. Rudolph, H. Joe, and J. Frohlinger, U. of Pittsburgh (B13)                         | Indoor-outdoor relationships for dust of outdoor origin | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |     | X        |               |      |       |            |
| 124      | U. of Michigan              | J. Jones, F. Higgins, M. Higgins, and J. Keller, U. of Michigan (B23)                                      | Case study of ventilation for control                   | X          |                 |                |                 | X                  | X                |       |                 | X  |      |          |     |          |               |      |       |            |
| 125      | LBL                         | J. Janssen and I. Hill, Honeywell; J. Woods, and E. Maldonado, Iowa State U. (B98)                         | Trace organics indoors                                  | X          | X               |                |                 | X                  | X                |       |                 |    |      |          |     | X        |               |      |       |            |
| 126      | LBL                         | Millsch, Hollowell, Fanning, Newton, Schmidt, LBL (B51)                                                    | Particulate-Radon Interaction                           |            |                 |                |                 | X                  | X                | X     |                 |    |      |          |     |          |               |      |       |            |
| 127      | LBL                         | D. Grimsrud, LBL (C6)                                                                                      | IAQ control techniques                                  |            |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |
| 128      | LBL                         | D. Grimsrud, LBL (C7)                                                                                      | Asbestos abatement in schools                           |            |                 |                |                 | X                  | X                |       |                 | X  |      |          |     |          |               |      |       |            |
| 129      | Yale University             | Sawyer, R., and E. Swoszowski, Yale U. (B115)                                                              | Measurement of aerosols in offices                      | X          | X               |                |                 |                    |                  |       |                 |    |      | X        | X   |          |               |      |       |            |
| 130      | TSI, Inc.                   | R. Quent, P. Nelson, and G. Sem, TSI (B2)                                                                  | Spatial variation of CO and NO <sub>2</sub> in houses   | X          |                 |                |                 |                    |                  |       |                 |    |      |          |     | X        | X             |      |       |            |
| 131      | ITTNI                       | D. Moschandraas, ITTNI; J. Zabrensky, Geomet (B35)                                                         | Tracer development                                      | X          |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 132      | ITTNI                       | D. Moschandraas, ITTNI (C47)                                                                               | Ozone in residences                                     | X          |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 133      | Honeywell, Inc.             | D. Sutton, K. Rodolf, and K. K. Makino, Honeywell (B141)                                                   | Predicting ozone concentrations in homes                |            |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 134      | Honeywell, Inc.             | D. Sutton, K. Rodolf, and K. Makino, Honeywell, Inc.                                                       | Organics in telephone central offices                   |            |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 135      | GIE                         | Oulas, D., Dugger, D., and S. Lieberman, GIE (B54)                                                         | Ozone decomposition rates                               | X          |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 136      | GIE (Louisville)            | F. Mueller, L. Leub, and M. Napes, GE (B140)                                                               | Low dose radon dosimetry: methods and theory            | X          | X               |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 137      | GE R&D Center (Schenectady) | R. Fleisher, W. Giard, A. Negro-Camparo, and L. Turner, GE; H. Alter and J. Gierlich, Ferradex Corp. (B5a) |                                                         | X          | X               |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |

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TABLE 3-1 (continued)

| Inv. No. | Sponsor                             | Investigator & organization (cross reference) <sup>a</sup>                                      | Subject                                                                       | Study Area |                 |                |                 |                    | Pollutant        |       |                 |    |      |          |     |          |               |      |       |            |
|----------|-------------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|----------|-----|----------|---------------|------|-------|------------|
|          |                                     |                                                                                                 |                                                                               | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | MCHM | Asbestos | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological |
| 138      | GE RAD Center                       | Robert Fleischer, GE (B110)                                                                     | Lung cancer and phosphates                                                    |            |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 139      | J. B. Pierce Foundation             | Stolwijk and Leederer, J. B. Pierce Lab (C38)                                                   | Epidemiological study of residential exposure to combustion and tobacco smoke | X          |                 | X              | X               | X                  | X                | X     | X               | X  | X    | X        | X   |          |               |      |       | X          |
| 140      | J. B. Pierce Foundation             | M. Schachter, J. B. Pierce Lab (C39)                                                            | Irritation effects of formaldehyde                                            |            |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 141      | BPA                                 | D. Grimsrud, IRL (CB)                                                                           | Residential and commercial survey for retrofit effects on IAQ                 | X          |                 |                |                 |                    | X                | X     | X               | X  | X    | X        | X   |          |               |      |       |            |
| 142      | Pac. Power & Light                  | D. Zerba, Battelle Northwest (C52)                                                              | Residential ventilation                                                       | X          |                 |                |                 |                    | X                | X     | X               | X  | X    |          |     |          |               |      |       | X          |
| 143      | Misc. Power & Light                 | J. Spengler, R. Letz, Harvard School of P.H.; J. Quackenbush, M. Kanarek, U. of Wisconsin (B36) | Personal monitoring for NO <sub>2</sub>                                       | X          |                 |                |                 |                    | X                | X     | X               | X  |      |          |     |          |               |      |       | X          |
| 144      | Wisconsin Power and Light           | J. Quackenbush, U. of Wisconsin (Harvard support) (C53)                                         | Weatherization & IAQ                                                          | X          |                 | X              | X               |                    | X                | X     | X               | X  | X    | X        | X   | X        |               |      |       | X          |
| 145      | Nat. Kerosene Heaters Ass., Kerosun | K. Jones, R. F. Weston (C54)                                                                    | IAQ from kerosene heaters                                                     | X          | X               |                |                 |                    | X                | X     | X               | X  | X    | X        |     |          |               |      |       | X          |
| 146      | Niagara Mohawk and NYERDA           | G. Adams, Niagara Mohawk, W. S. Fleming, contractor (C55)                                       | Residential & commercial IAQ                                                  | X          |                 |                |                 |                    | X                | X     | X               | X  | X    | X        | X   | X        |               |      |       | X          |
| 147      | Philip Morris, Inc.                 | D. Good, C. Vilcins, W. Harvey, D. Clabo, and A. Lewis, Philip Morris (B32)                     | Smoking effects on residential NO <sub>2</sub>                                | X          |                 |                |                 |                    | X                | X     | X               |    |      |          |     |          |               |      |       |            |
| 148      | Systems, Science and Software       | P. Iagou, Systems, Science and Software (B101)                                                  | Tracer-dilution method for infiltration                                       |            |                 |                |                 | X                  |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 149      | Rand Corporation                    | Maihua Duan, Rand Corporation (B131)                                                            | Human exposure models to air pollution                                        |            |                 |                |                 |                    | X                |       |                 |    |      |          |     |          |               |      |       |            |
| 150      | Bell Laboratories                   | C. Meschter, Bell Telephone (B4) (B110)                                                         | Characterization of organics in aerosols                                      | X          |                 |                |                 |                    | X                |       |                 |    |      |          |     |          |               |      |       | X          |
| 151      | Bell Labs                           | C. Meschter, S. Kelly, and J. Lingusky, Bell (B110)                                             | Effect of lens on dust levels                                                 |            |                 |                |                 |                    |                  |       |                 |    |      |          |     |          |               |      |       |            |
| 152      | Geomet                              | D. Muschandreass, IIRI; H. Rector, Geomet (B65)                                                 | Indoor radon                                                                  | X          |                 |                |                 |                    | X                |       |                 |    |      |          |     |          |               |      |       |            |

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TABLE 3-1 (continued)

| Inv. No. | Sponsor                                   | Investigator & organization (cross reference) <sup>a</sup>                                                                                                                                 | Subject                                                | Study Area |                 |                |                 |                    |                  |       |                 |    |      | Pollutant |     |          |               |      |       |            |                |  |  |
|----------|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|-----------|-----|----------|---------------|------|-------|------------|----------------|--|--|
|          |                                           |                                                                                                                                                                                            |                                                        | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO | Asbestos  | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutant |  |  |
| 153      | Gestet                                    | H. Nagda, Gestet (C50)                                                                                                                                                                     | Respirable particulate exposure                        | X          | X               |                |                 |                    |                  |       |                 |    |      |           | X   |          |               |      |       |            |                |  |  |
| 154      | TRC                                       | J. Yocum, TRC Environmental Consultants (C57)                                                                                                                                              | Indoor air quality research at TRC                     | X          |                 | X              | X               |                    | X                | X     | X               | X  | X    | X         | X   | X        | X             | X    | X     | X          |                |  |  |
| 155      | TRC                                       | John Yocum, TRC (B23)                                                                                                                                                                      | Indoor/outdoor air quality relationships               | X          |                 |                |                 |                    | X                | X     | X               | X  | X    | X         |     | X        | X             |      |       | X          |                |  |  |
| 156      | Various                                   | D. Moschandreas, IITRI (C44)                                                                                                                                                               | Odor                                                   |            |                 |                |                 |                    | X                |       |                 |    |      |           |     |          |               |      |       | X          |                |  |  |
| 157      | Private (confidential)                    | D. Moschandreas, IITRI (C45)                                                                                                                                                               | Particulate control device                             |            |                 |                |                 | X                  |                  |       |                 |    |      |           | X   |          |               |      |       | X          |                |  |  |
| 158      | Private (confidential)                    | D. Moschandreas, IITRI (C46)                                                                                                                                                               | Woodstove-PAH emissions                                | X          |                 |                |                 | X                  | X                | X     | X               |    |      |           |     |          |               |      |       | X          |                |  |  |
| 159      | Various manufacturers                     | Enno Iomasa, Underwriters Lab Inc. (C56)                                                                                                                                                   | Kerosene heater certification                          |            |                 |                |                 | X                  | X                | X     | X               |    |      |           |     |          |               |      |       | X          |                |  |  |
| 160      | Various manufacturers                     | Kathy Blair, PFS Corporation (C60)                                                                                                                                                         | Kerosene heater certification                          |            |                 |                |                 | X                  |                  | X     | X               |    |      |           |     |          |               |      |       |            |                |  |  |
| 161      | CPSC                                      | Warren Porter, CPSC (C59)                                                                                                                                                                  | Evaluation of kerosene heater emissions                |            |                 |                |                 | X                  | X                | X     | X               | X  | X    |           |     |          |               |      |       | X          |                |  |  |
| 162      | French laboratories                       | P. Sebastian, Laboratoire d'Etude des Particules Inhalées; J. Bignon, Inst. Nat. de la Santé et de la Recherche Médicale; H. Martin, Ecole Centrale des Arts et Manufactures de Paris (B9) | Ceiling & floor asbestos contamination                 | X          |                 |                |                 | X                  |                  | X     | X               | X  | X    | X         |     |          |               |      |       |            |                |  |  |
| 163      | SPWS (France)                             | F. Lorenz, Laboratoire de Physique du Bâtiment (B133)                                                                                                                                      | Ventilation requirements in parking garages            | X          |                 |                |                 | X                  |                  | X     |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 164      | Tokyo foundation                          | H. Mita and K. Maeda, U. of Tokyo (B25)                                                                                                                                                    | NO <sub>2</sub> monitoring                             | X          |                 |                |                 | X                  |                  | X     |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 165      | EPA of Japan                              | S. Yamazaki, H. Hirose, and S. Takada, Kyoto City Inst. of Public Health (B05)                                                                                                             | NO <sub>2</sub> from kerosene and gas-fired appliances | X          |                 |                |                 | X                  |                  | X     |                 |    |      |           |     |          |               |      |       |            |                |  |  |
| 166      | U. of Tokyo                               | Y. Yanagisawa and H. Hishimura, Chem. Engineering Dept., U. of Tokyo (B39)                                                                                                                 | Filter badge sampler for NO <sub>2</sub> and NO        | X          |                 |                |                 | X                  |                  | X     | X               | X  | X    |           |     |          |               |      |       | X          |                |  |  |
| 167      | Japan Tobacco and Salt Public Corporation | Y. Ishizu, Jap. Tab. & Salt Pub. Corp. (B127)                                                                                                                                              | Equation for estimating pollution                      | X          |                 |                |                 | X                  |                  |       |                 |    |      |           |     |          |               |      |       | X          |                |  |  |

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TABLE 3-1 (continued)

| Inv. No. | Sponsor                                     | Investigator & organization <sup>a</sup>                                                                                 | Subject                                                           | Study Area |                 |                |                 |                    |                  |       |                 |    |      | Pollutant |          |     |          |               |      |       |
|----------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|-----------|----------|-----|----------|---------------|------|-------|
|          |                                             |                                                                                                                          |                                                                   | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO |           | Asbestos | TSP | Organics | Tobacco Smoke | Odor | Ozone |
| 168      | Chiba Inst. of Tech., Osaka City U.         | M. Harasaki, S. Ishido, Chiba Inst.; Y. Nakane, Osaka City U. (B104)                                                     | Indoor air pollution and ventilation in dining rooms and kitchens |            |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 169      | Canadian Testing and Research               | T. Sterling, Simon Fraser U.; D. Kobayashi, Columbia U. (B89)                                                            | Gas range pollutants                                              | X          |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 170      | WHO                                         | Silverman, P. Corey, S. Mintz, P. Oliver, and R. Hosain, Gage Research Inst. (B28)                                       | Personal samplers for ambient air pollution                       | X          |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 171      | WHO                                         | K. Sega and M. Fugas, Inst. for Med. Res. and Occupational Health, Yugoslavia (B27)                                      | Personal vs. general monitoring for respirable particles          | X          |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 172      | Arya-Mehr U. of Technology (Iran)           | Rashidi, Hassoudi, and Shadman, U. of Tech. (B112)                                                                       | Kerosene heating CO reduction                                     | X          |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 173      | U. of Petroleum and Minerals (Saudi Arabia) | Abu-Jarad, U. of Petroleum and Minerals (Saudi Arabia); J. Franklin, U. of Birmingham, England (B56)                     | Radon in high-rise buildings                                      | X          |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 174      | Pittington Brothers Limited (England)       | J. Hill, W. Whitehead, J. Cameron, and G. Hedgecock, Pittington Bros. Ltd. (B122)                                        | Absence of pulmonary hazard due to glass fibers                   |            |                 | X              | X               |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 175      | Swedish Council Building Research (SBR)     | T. Malmstrom and A. Ahlgren, Royal Inst. of Tech. (B102)                                                                 | Office room ventilation                                           | X          |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 176      | SCBR                                        | B. Berglund, Univ. of Stockholm; T. Lindvall, Karolinska Institute (B40)                                                 | New preschool air contaminants                                    | X          |                 |                |                 | X                  | X                |       |                 |    |      |           |          |     |          |               |      |       |
| 177      | SCBR                                        | B. Berglund, Univ. of Stockholm; T. Lindvall, Karolinska Institute (B91)                                                 | Influence of ventilation in office indoor/outdoor contaminants    | X          |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 178      | SCBR                                        | B. Berglund, H. Nicander-Björkberg, Univ. of Stockholm; J. Berglund and T. Lindvall, Nat. Inst. of Envtl. Medicine (B67) | Psychophysical model of air quality                               |            |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |
| 179      | Peterson AB--Sweden                         | B. Sodergren, Peterson AB--Sweden (B108)                                                                                 | CO <sub>2</sub> ventilation                                       | X          |                 |                |                 |                    |                  |       |                 |    |      |           |          |     |          |               |      |       |

See footnote at end of table.

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TABLE 3-1 (continued)

| Inv. No. | Sponsor                             | Investigator & organization (cross reference) <sup>a</sup>                                                                        | Subject                                                | Study Area |                 |                |                 |                    | Pollutant        |       |                 |    |      |          |     |          |               |      |       |            |                |
|----------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|------------|-----------------|----------------|-----------------|--------------------|------------------|-------|-----------------|----|------|----------|-----|----------|---------------|------|-------|------------|----------------|
|          |                                     |                                                                                                                                   |                                                        | Monitoring | Instrumentation | Health Effects | Risk Assessment | Control Technology | Characterization | Radon | NO <sub>x</sub> | CO | HCHO | Asbestos | TSP | Organics | Tobacco Smoke | Odor | Ozone | Biological | Multipollutant |
| 180      | Swedish Nat. Testing                | O. Hildingsson, Swedish Nat. Testing (B61)                                                                                        | Radon in Swedish homes                                 | X          |                 | X              |                 | X                  | X                | X     |                 |    |      |          |     |          |               |      |       |            |                |
| 181      | Lund Inst. of Tech. (Sweden)        | H. Lannefors and H. Hansson, Lund Inst. (B19)                                                                                     | Nursery school elemental indoor/outdoor concentrations | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            | X              |
| 182      | Danish National Health Foundation   | L. Holhave, U. of Aarhus (Denmark) (B139)                                                                                         | Building material organic pollutants                   | X          | X               |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            | X              |
| 183      | U. of Aarhus                        | F. Andersen, G. Lundqvist, and L. Holhave, U. of Aarhus (B138)                                                                    | Chipboard indoor pollution                             | X          |                 |                |                 | X                  | X                |       |                 |    | X    |          |     |          |               |      |       |            |                |
| 184      | U. of Aarhus                        | G. Lundqvist, H. Iversen, and J. Korsgaard, U. of Aarhus (B34)                                                                    | Day care climate with low ventilation                  | X          |                 |                |                 | X                  | X                |       |                 | X  |      |          |     |          |               |      |       |            | X              |
| 185      | U. of Copenhagen                    | J. Olsen and H. Bøssing, U. of Copenhagen (B127)                                                                                  | Formaldehyde symptoms in day care centers              | X          | X               |                |                 | X                  | X                |       |                 | X  |      |          |     |          |               |      |       |            |                |
| 186      | Techn. U. of Denmark                | M. Jonassen, Techn. U. of Denmark; J. McLaughlin, U. College, Dublin (B63)                                                        | Air filtration and radon daughter levels               |            |                 |                |                 | X                  | X                | X     |                 |    |      |          |     |          |               |      |       |            |                |
| 187      | Technical U. of Denmark             | M. Jonassen, Technical U. of Denmark (B62)                                                                                        | Radon and building materials control of radon          | X          | X               |                |                 | X                  | X                | X     |                 |    |      |          |     |          |               |      |       |            |                |
| 188      | U. of Denmark                       | B. Berg-Hunch and F. Fanger, U. of Denmark (B86)                                                                                  | Air temperature influence on body odor perception      | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 189      | Norwegian Inst. of Tech             | E. Skaret and H. Mathisen, Norwegian Inst. of Tech. (B107)                                                                        | Ventilation efficiency                                 | X          |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 190      | U. of Kuopio (Finland)              | P. Kalliohoki, U. of Kuopio; R. Niemela, Inst. of Occupational Health; J. Salmivaara, Technical Research Center of Finland (B100) | Tracer gas technique for industrial hygiene            | X          |                 |                |                 | X                  | X                |       | X               | X  |      |          |     |          |               |      |       |            | X              |
| 191      | Bundesministerium (W. Germany)      | J. Postendorfer, A. Wicke, and A. Schraub, Inst. für Biophysik (B136)                                                             | Effects on radon concentrations                        |            |                 |                |                 | X                  | X                |       |                 |    |      |          |     |          |               |      |       |            |                |
| 192      | Federal Inst. of Technology, Zurich | A. Weber-Tschopp, A. Fischer, and E. Grandjean, Fed. Inst. of Tech. (B7)                                                          | Physiologic and irritating effects of cigarette smoke  | X          | X               |                |                 | X                  | X                |       | X               | X  | X    |          |     |          |               |      |       |            |                |
| 193      | U. de Santiago, (Chile)             | I. Careros, H. Soto E. Lissi, U. de Santiago; R. Cisternas, U. Católica, (Chile) (B72)                                            | Appliance emissions and indoor concentrations          | X          |                 |                |                 | X                  | X                |       | X               | X  | X    | X        |     |          |               |      |       |            | X              |

<sup>a</sup> Numbers preceded by "B" denote references in the Annotated Bibliography (Section 4.0). Numbers preceded by "C" refer to the contact summaries (Section 6.0).

TABLE 3-2. SUMMARY OF SPECIAL CAPABILITIES FOR INDOOR AIR QUALITY RESEARCH

| Organization                                                                       | Special facilities                                                                                                                | Inv. number<br>(see Table 3-1) |
|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| DOE<br>New York, NY<br>E. Knutson, 212-620-3652                                    | Research chamber--20 m <sup>3</sup> , temperature and humidity controlled                                                         | 26                             |
| EPA/NIERL<br>Research Triangle Park, NC<br>Kathryn MacLeod, 919-541-2281           | Research chamber--30 m <sup>3</sup> , instrument testing, polyurethane foam emissions testing                                     | 29-31                          |
| EPA/ESRL<br>Research Triangle Park, NC<br>Frank Black, 919-629-3037                | Research chamber--vehicle emissions, refrigeration for cold weather simulation                                                    | 33                             |
| Brookhaven National<br>Laboratory<br>Upton, NY 11973<br>Russel Dietz, 516-282-2123 | Perfluorocarbon tracer developed for infiltration studies (BNL/AIMS)                                                              | 25                             |
| Argonne National Laboratory<br>Argonne, Illinois<br>J. Rundo, 312-972-4156         | Research chamber--6 m <sup>3</sup> , radiation research                                                                           | 27                             |
| ORNL<br>Oak Ridge, TN 37830<br>T. Matthews, 615-574-6248                           | 3 research chambers--0.2 m <sup>3</sup> , teflon lined<br>4 research houses--1 has 110 m <sup>3</sup> 0.3 - 0.5 ach <sup>-1</sup> | 22-24, 74,<br>77, 78           |
| Naval Research Laboratory<br>Washington, DC 20375<br>Alfred Lowry, 202-545-6700    | Research chambers--ventilation controlled                                                                                         | 110                            |

(continued)

TABLE 3-2 (continued)

| Organization                                                                                                         | Special facilities                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Inv. number<br>(see Table 3-1) |
|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Consumer Products Safety<br>Commission<br>Washington, DC<br>Warren Porter, 301-245-1445                              | Research chamber--25 m <sup>3</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 161                            |
| LBL<br>Berkeley, CA<br>D. Grimsrud, 415-486-4023                                                                     | 3 research chambers--27 m <sup>3</sup> -ventilation controlled;<br>--30 m <sup>3</sup> (stainless steel construction)<br>temperature, humidity and ventilation<br>controlled<br>--30 m <sup>3</sup> (gypsumboard construction)<br>Residence prototype--Radon research facility with remote data<br>acquisition<br>--testing for heat exchangers and HCOH with<br>temperature, humidity, and ventilation<br>control<br>--260 m <sup>3</sup>                                                          | 1-15, 75,<br>126-128,<br>141   |
| J. B. Pierce Foundation<br>Laboratory<br>New Haven, CT<br>B. P. Leaderer, 203-562-9901                               | Mobile Atmospheric Research Laboratory (MARL)<br>Research facility for passive monitor testing with temperature,<br>humidity, and ventilation control<br>3 thermal chambers for physiological research<br>1 test chamber--34 m <sup>3</sup> , ventilation, temperature, and humidity<br>controlled (aluminum construction)<br>Mobile monitors--CO, CO <sub>2</sub> , O <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub><br>Pollutant generation capability<br>Odor testing--psychophysical research | 16, 17, 66,<br>71, 130,<br>140 |
| Princeton U. Center for<br>Energy and Environ-<br>mental Studies<br>Princeton, NJ 08544<br>Dave Harrie, 609-452-5445 | Research chamber--16 m <sup>3</sup> ventilation controlled, extensive<br>instrumentation                                                                                                                                                                                                                                                                                                                                                                                                            | 18, 19                         |

(continued)

TABLE 3-2 (continued)

| Organization                                                                                                          | Special facilities                                                                                                                                                                                                                                                                                        | Inv. number<br>(see Table 3-1)                  |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| Harvard School of Public<br>Health<br>Boston, MA 02115<br>John Spengler, 617-732-1255                                 | Research chamber--78 m <sup>3</sup> , ventilation controlled                                                                                                                                                                                                                                              | 43-45, 57-<br>63, 100,<br>113, 120,<br>143, 144 |
| RTI<br>Research Triangle Park,<br>NC 27709<br>Edo Pellizzari, 919-541-6579                                            | 4 research chambers--18 m <sup>3</sup> , 3.6 m <sup>3</sup> , 0.7 m <sup>3</sup> , 0.04 m <sup>3</sup><br>Mobile monitoring laboratory<br>Personal monitors--pesticides, PCB's<br>Spirometer developed to breath analysis                                                                                 | 35-40, 81                                       |
| IITRI<br>Chicago, IL 60616<br>D. Moschandreas, 312-567-4310                                                           | 2 research chambers--32 m <sup>3</sup> for human exposure studies,<br>temperature, humidity, and ventilation<br>controlled<br>--28 m <sup>3</sup> for control device evaluation<br>Mobile monitoring laboratory--air quality, infiltration odor,<br>and meteorological testing<br>Sensory lab--odor panel | 95, 101, 131,<br>132, 152,<br>156-158           |
| U. of Illinois<br>Chicago, IL 60680<br>Richard Wadden, 312-996-0810                                                   | Electrical aerosol analyses, condensation nuclei counter,<br>nebulizers<br>Standard measurement systems                                                                                                                                                                                                   | 53, 108,<br>118                                 |
| Lovelace Biomedical and<br>Environmental Research<br>Institute<br>Albuquerque, NM 87115<br>Brian Mokler, 505-844-2203 | 3 research chambers--1.0 m <sup>3</sup> ventilation controlled<br>--2.0 m <sup>3</sup> ventilation controlled<br>--8.0 m <sup>3</sup> ventilation controlled                                                                                                                                              | 20, 21, 79                                      |
| Carnegie Mellon U.<br>Pittsburgh, PA<br>C. Davidson, 412-578-2951                                                     | Research house--ventilation controlled, remote computer-assisted<br>data acquisition system                                                                                                                                                                                                               | 87                                              |

(continued)

TABLE 3-2 (continued)

| Organization                                                         | Special facilities                                                                                                                                                                                                                                                                            | Inv. number<br>(see Table 3-1) |
|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Geomet, Inc.<br>Gaithersburg, MD<br>N. L. Nagda, 301-424-9133        | 2 research houses--325 m <sup>3</sup> each<br>Mobile monitoring laboratory--radiation, criteria pollutants,<br>tracer studies (SF <sub>6</sub> )                                                                                                                                              | 103, 104,<br>131, 152,<br>153  |
| Battelle Columbus<br>Columbus, OH<br>Ralph Mitchell, 614-424-7441    | 2 research chambers--17 m <sup>3</sup><br>Mobile monitoring laboratory--criteria pollutants, tracer<br>studies, (SF <sub>6</sub> ), radiation                                                                                                                                                 | 55                             |
| TRC<br>East Hartford, CT<br>John Yocum, 203-289-8631                 | Trace atmospheric gas analyzer (mass spectrometer)<br>Odor testing<br>Standards laboratory                                                                                                                                                                                                    | 105, 154,<br>155               |
| Pacific Power and<br>Light<br>Portland, OR<br>D. Zerba, 503-243-4876 | 3 test houses--100-140 m <sup>2</sup><br>--1 energy conserving<br>1 conventional construction test facility                                                                                                                                                                                   | 142                            |
| R. F. Weston, Inc.<br>West Chester, PA<br>K. Jones, 215-692-3030     | Mobile monitoring lab--GC-MS analysis                                                                                                                                                                                                                                                         | 145                            |
| General Electric<br>Louisville, KY<br>Leopold Loeb, 502-452-4603     | 3 research chambers--7.1 m <sup>3</sup> , testing for odors and pollutants,<br>ventilation controlled (aluminum<br>construction)<br>--39.0 m <sup>3</sup> ventilation controlled (aluminum<br>construction)<br>--48.7 m <sup>3</sup> ventilation controlled (stainless<br>steel construction) | 136                            |

(continued)



TABLE 3-2. (continued)

| Organization                                            | Special facilities                                                                                              | Inv. number<br>(see Table 3-1) |
|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|--------------------------------|
| U. of Aarhus, Inst. of<br>Hygiene<br>Denmark            | 3 research chambers<br>Climate chamber--1.0 m <sup>3</sup> (stainless steel construction)                       | 183-184                        |
| Technical U. of Denmark                                 | Research chamber--324 m <sup>3</sup> , for ventilation experiments                                              | 186                            |
| Norwegian Institute of<br>Technology<br>Norway          | Research chamber--81 m <sup>3</sup> , ventilation controlled                                                    | 189                            |
| Federal Inst. of Tech-<br>nology<br>Zurich, Switzerland | Research chamber--30 m <sup>3</sup> , climate and ventilation controlled,<br>organics and inorganics monitoring | 192                            |
| U. of Tokyo, Chemical<br>Eng. Dept.<br>Japan            | NO and NO <sub>2</sub> filter badge sampler developed                                                           | 166                            |
| Arya-Mehr University of<br>Technology<br>Tehran, Iran   | Research chamber--7.5 m <sup>3</sup> , silver-paint lined, temperature<br>and ventilation controlled            | 172                            |



#### 4.0 ANNOTATED BIBLIOGRAPHY

This section provides an annotated bibliography of selected recent literature on indoor air quality and a follow-on bibliography for the period October 1983 through December 1984. The bibliographies are arranged by subject. The bulk of the citations in the bibliography are from peer-reviewed journal articles, dated from 1980. Presentations from a few, very recent symposia are also included to provide the most current work. Government reports have not been included, except where they are annotated bibliographies, literature reviews, or general treatises. Some articles prior to 1980 were included because the subject matter seemed unique or the article represented a major work that was frequently cited thereafter.

As shown in the Outline (p. 30), the bibliography is organized under five major headings: I. Characterization and Measurement; II. Control; III. Health Studies; IV. Modeling; and V. General Reviews. The first, second, and fourth of these subject areas were of prime concern for this project and, consequently, have been further divided into specific topics as shown in the outline. Many articles, of course, span several subject areas; where this occurs, the work was classified according to the primary objective of the research.

The summary information for each annotated citation is organized as follows: citations are listed alphabetically by principal author within each category or subcategory; underneath the citation is a capsule summary providing the names of the investigating organization and sponsor, pollutants measured, pollutant sources, premises, geographical location, season, ventilation rates, and major findings. Most articles do not address all of these considerations, hence "NA" is used to denote "not applicable." In some cases "NA" may mean "not available," as in those cases where the sponsoring agency is not provided, but the distinction should be clear from the context. Following each citation, one or more of the letters "A" through "F" appear in brackets. These represent a shorthand classification scheme as follows:

- A - Monitoring
- B - Instrumentation
- C - Health Effects
- D - Risk Assessment
- E - Control Technology
- F - Characterization

This scheme provides both a cross-referencing to Table 3-1 (under the heading "Study Area") and a succinct characterization of the work.

The Annotated Bibliography is by no means complete. Nevertheless, several observations may be made about these studies and perhaps generalized to indoor air quality research. The area we have labeled "Characterization and Measurement" has certainly received the most attention. Researchers have expended much effort to sample various premises for levels of certain pollutants. Sometimes an identified pollutant source such as a gas-fired range is present; in other cases, a large number of premises are sampled to determine an average level, or an attempt is made to relate indoor pollutant levels to outdoor levels. These studies seem to reflect an older perception that indoor air quality is determined largely by outdoor air quality. Two significant changes in the habits of building occupants tend to challenge this perception. First, the reduction of air infiltration rates to conserve energy has further insulated the indoor environment from outdoor air, and second, the popularity of unvented combustion sources for space heating suggests that indoor pollutant sources may be far greater than outdoor sources. However, very few studies have attempted to determine emission rates from these unvented combustion sources.

In the area of "Control Methods", the majority of studies have measured the effect of ventilation rates on indoor air quality. This trend may also reflect the early emphasis on ventilation as the principal control option. Very few studies deal with other control options such as air purification and only one study considered source modification to reduce emission rates. In the area of "Modeling," several studies attempted to predict indoor pollutant levels using mass-balance approaches. These models typically consider only one or perhaps a few pollutants and are therefore incomplete in characterizing the indoor environment. The accuracy of these models is also limited by the input parameters such as source emission rates and mixing factors.

In summary, based on our review of the articles contained in the annotated bibliography, several study areas appear to deserve further investigation. These include: the determination of source emission rates, especially with regard to the use of these rates in mathematical models; further study of control options for pollutant sources, such as air-purifying devices and

source modification; and more sophisticated modeling efforts that consider more than one or two pollutants.

The update bibliography, also, is not complete. Most of the citations were identified from computer searches of two databases, ENVIROLINE and CA (Chemical Abstracts). Many articles (approximately 110 of the 183 total citations) were selected from the international conference held in Stockholm, Sweden (September 1984), although a large percentage of the Stockholm citations had not been identified through the literature searches. Several individual articles were not available through local university libraries nor through the normal RTI library channels. Articles, for which no hard copy could be reasonably attained, were not included in the bibliography.

#### 4.1 Outline of Bibliography

##### I. CHARACTERIZATION AND MEASUREMENT

###### A. Aerosols

1. Indoor aerosols
2. Tobacco smoke
3. Asbestos
4. Fibrous glass and mineral wool
5. Viable aerosols

###### B. Indoor-Outdoor Relationships

1. Fixed site
2. Exposure monitoring

###### C. Gaseous Pollutants

1. Inorganics
2. Organics

###### D. Radon

###### E. Consumer products

###### F. Combustion sources

###### G. Odor

##### II. CONTROL METHODS

###### A. Air-purifying methods

###### B. Ventilation

###### C. Source modification

###### D. Miscellaneous

##### III. HEALTH STUDIES

##### IV. MODELING

###### A. General models

###### B. Radon

###### C. Formaldehyde

###### D. Ozone

##### V. GENERAL REVIEWS: INDOOR AIR QUALITY

###### A. Treatises

###### B. Bibliographies

###### C. Miscellaneous

## 4.2 Annotated Bibliography

### I. CHARACTERIZATION AND MEASUREMENT

#### A1. Aerosols: Indoor aerosols

1. Ju, C., and J. D. Spengler. 1981. Room-to-room variations in concentration of respirable particles in residences. Environmental Science & Technology 15(5):592-596. [A, F]

Investigator: Harvard School of Public Health

Sponsor: NIEHS; EPRI

Pollutants Measured: respirable particles

Pollutant Sources: NA

Premises: homes

Geographical Location: Boston, MA

Season: Nov-Feb

Ventilation Rates: NA

Major Findings: Respirable particle concentrations were measured in four homes located in the metropolitan Boston area. Based on an analysis of variance, two homes showed significant differences between rooms, but the other two homes showed no significant differences ( $P < 0.05$ ). Whereas outdoor concentrations were found to be comparable, indoor concentrations varied greatly.

2. Quant, F. R., P. A. Nelson, and G. J. Sem. 1982. Experimental measurements of aerosol concentrations in offices. Environment International 8:223-227. [A, B]

Investigator: TSI, Inc.

Sponsor: TSI, Inc.

Pollutants Measured: aerosols less than 10  $\mu\text{m}$

Pollutant Sources: NA

Premises: offices

Geographical Location: St. Paul, MN

Season: NA

Ventilation Rates: NA

Major Findings: A new automated version of the piezoelectric microbalance was used to sample particles (less than 10  $\mu\text{m}$ ) in several offices. The effect of a single smoker was evident in the time-series data.



## I. CHARACTERIZATION AND MEASUREMENT

### A1. Aerosols: Indoor aerosols (continued)

3. Spengler, J. D., D. W. Dockery, W. A. Turner, J. M. Wolfson, and B. G. Ferris, Jr. 1981. Long-term measurements of respirable sulfates and particles inside and outside homes. Atmospheric Environment 15:23-30. [A, F]

Investigator: Harvard School of Public Health  
Sponsor: NIEHS; EPRI  
Pollutants Measured: respirable particles  
Pollutant Sources: NA  
Premises: homes  
Geographical Location: six cities  
Season: year-round  
Ventilation Rates: NA

Major Findings: Indoor and outdoor monitoring for respirable particles and the sulfate fraction of these particles are reported. Homes were monitored in six U.S. cities. The major source of indoor particulate matter is cigarette smoke which contributes about 20  $\mu\text{g}/\text{m}^3$  to indoor concentrations for each smoker. Even in homes without smokers, indoor particle concentrations equal or exceed outdoor levels.

4. Weschler, C. J. 1980. Characterization of selected organics in size-fractionated indoor aerosols. Environmental Science & Technology 14(4): 428-431. [A, F]

Investigator: Bell Telephone Labs  
Sponsor: Bell Telephone Labs  
Pollutants Measured: size-fractionated aerosols, organics  
Pollutant Sources: NA  
Premises: Bell Labs  
Geographical Location: Holmdel, NJ  
Season: Jan-Aug  
Ventilation Rates: 10% make-up outside

Major Findings: A variety of organic compounds were extracted from size-fractionated indoor aerosol samples. Among these were aliphatic alcohols, phosphate esters, and phthalate ester plasticizers.



## I. CHARACTERIZATION AND MEASUREMENT

### A2. Aerosols: Tobacco smoke

5. Repace, J. L. and A. H. Lowrey. 1980. Indoor air pollution, tobacco smoke, and public health. Science 208:464-472. [A, D, F]

Investigator: Private capacity

Sponsor: Prince George's Environmental Coalition

Pollutants Measured: respirable particles

Pollutant Sources: tobacco smoke

Premises: various public places

Geographical Location: Washington, DC

Season: Mar-Jun

Ventilation Rates: 0.7-9.4 ach

Major Findings: An experimental and theoretical investigation is made into the range and nature of exposure by the nonsmoking public to respirable suspended particles from cigarette smoke. A modified Turk model incorporating both physical and sociological parameter is shown to be useful in understanding particulate levels from cigarette smoke in indoor environments. It is shown that nonsmokers are exposed to significant air pollution burdens from indoor smoking.

6. Sterling, T. D., H. Dimich, and D. Kobayashi. 1982. Indoor byproduct levels of tobacco smoke: A critical review of the literature. JAPCA 32(3):250-259. [A, F]

Investigator: Simon Fraser & Columbia Universities

Sponsor: NAS/NRC

Pollutants Measured: cigarette combustion products

Pollutant Sources: cigarette smoking

Premises: varied

Geographical Location: varied

Season: NA

Ventilation Rates: varied

Major Findings: Levels reported in diverse publications of cigarette combustion byproducts (gases and particles) are summarized in tabular form. Summaries also include information on test conditions such as ventilation, size and types of premises, monitoring conditions, number of smokers, and rate of smoking.

## I. CHARACTERIZATION AND MEASUREMENT

### A2. Aerosols: Tobacco smoke (continued)

7. Weber-Tschopp, A., A. Fischer, and E. Grandjean. 1976. Physiological and irritating effects of indoor air pollution due to cigarette smoke. In, Proceedings of the 6th Congress of the International Ergonomics Association and 20th annual meeting of The Human Factor Society (11-16 July), pp. 286-289. University of Maryland at College Park. [A, C, F]

Investigator: Federal Institute of Technology, Zurich

Sponsor: NA

Pollutants Measured: CO, NO, NO<sub>2</sub>, formaldehyde, acrolein

Pollutant Sources: cigarette smoking

Premises: climate chamber

Geographical Location: NA

Season: NA

Ventilation Rates: 3 m<sup>3</sup>/h

Major Findings: Subjects were exposed to 28 minutes of cigarette smoke in a climate chamber. CO, NO, NO<sub>2</sub>, formaldehyde and acrolein levels were recorded. Eye and nose irritation, annoyance and blinking rate increased in relation to the number of smoked cigarettes. Annoyance about air quality and the wish to open the windows proved to be a very good criterion of air quality.

## I. CHARACTERIZATION AND MEASUREMENT

### A3. Aerosols: Asbestos

8. Nicholson, W. J., E. J. Swoszowski, Jr., A. N. Rohl, J. D. Todaro, and A. Adams. 1979. Asbestos contamination in United States schools from use of asbestos surfacing materials. Annals New York Academy of Sciences 330:587-596. [A, F]

Investigator: Mt. Sinai School of Medicine

Sponsor: NIEHS

Pollutants Measured: asbestos

Pollutant Sources: sprayed surfaces

Premises: schools

Geographical Location: NY; NJ

Season: NA

Ventilation Rates: NA

Major Findings: Ten schools in which asbestos materials were used as surface coatings were sampled. When significant asbestos levels were found, physical deterioration of the surface material was evident.

9. Sebastian, P., J. Bignon, and M. Martin. 1982. Indoor airborne asbestos pollution: from the ceiling and the floor. Science 216: 1410-1413. [A, F]

Investigator: French Laboratories

Sponsor: NA

Pollutants Measured: asbestos

Pollutant Sources: flooring tiles

Premises: office building

Geographical Location: 20 km south of Paris, France

Season: winter

Ventilation Rates: NA

Major Findings: Electron microscopic measurements of the concentrations of airborne asbestos were carried out in and outside an office building having ceilings sprayed with a crocidolite-containing material and floors covered with vinyl-chrysotile tiles. Under normal conditions in this building, the two asbestos-containing materials released fibers into the air. This is the first measurement of elevated concentrations of indoor airborne asbestos associated with the weathering of asbestos floor tiles during their service life.

I. CHARACTERIZATION AND MEASUREMENT

A4. Aerosols: Fibrous glass and mineral wool

10. Esmen, N., M. Corn, Y. Hammad, D. Whittier, and N. Kotsko. 1979. Summary of measurements of employee exposure to airborne dust and fiber in sixteen facilities producing man-made mineral fibers. American Industrial Hygiene Association Journal 40:108-117. [A, F]

Investigator: Univ. of Pittsburgh

Sponsor: EPA

Pollutants Measured: suspended particles (total); fibers

Pollutant Sources: fibrous glass and mineral wool production

Premises: sixteen production facilities

Geographical Location: varied

Season: NA

Ventilation Rates: NA

Major Findings: Measurements of worker exposure to airborne particles and fibers were made at sixteen production facilities. The nominal fiber size of the manufactured fibers and the average airborne fiber concentrations were highly correlated.

I. CHARACTERIZATION AND MEASUREMENT

A5. Aerosols: Viable aerosols

11. Sterling, D. A., C. Clark, and S. Bjornson. 1982. The effect of air control systems on the indoor distributions of viable particles. Environment International 8:409-414. [A, F]

Investigator: Univ. of Cincinnati Medical Center

Sponsor: Univ. of Cincinnati

Pollutants Measured: viable particles

Pollutant Sources: NA

Premises: wastewater treatment and sludge composting facilities

Geographical Location: Washington, DC

Season: autumn

Ventilation Rates: NA

Major Findings: Thermophilic organisms found at the facilities served as monitors for viable particles. The indoor concentration of viable particles were found to be affected by building design and use of conventional mechanical air systems. There was evidence of growth of viable particles within these mechanical air systems.



## I. CHARACTERIZATION AND MEASUREMENT

### B1. Indoor-Outdoor Relationships: Fixed site

12. Allen, R. J. and R. A. Wadden. 1982. Analysis of indoor concentrations of carbon monoxide and ozone in an urban hospital. Environmental Research 27:136-149. [A, F]

Investigator: Univ. of Illinois, School of Public Health

Sponsor: Chicago Lung Assoc.

Pollutants Measured: CO, O<sub>3</sub>

Pollutant Sources: NA

Premises: hospital

Geographical Location: Chicago, IL

Season: year-round

Ventilation Rates: 18% of air filtered and recirculated

Major Findings: Carbon monoxide levels averaged 0.2 to 1.3 ppm higher inside a hospital compared with outside levels. Ozone levels were higher outdoors on average. Predicted and observed annual averages were within 0.3 ppm for CO and 0.03 ppm for O<sub>3</sub>.

13. Alzona, J., B. L. Cohen, H. Rudolph, H. N. Jow, and J. O. Frohlinger. 1979. Indoor-outdoor relationships for airborne particulate matter of outdoor origin. Atmospheric Environment 13:55-60. [A, F]

Investigator: Univ. of Pittsburgh

Sponsor: NA

Pollutants Measured: Fe, Zn, Pb, Br, Ca

Pollutant Sources: NA

Premises: various closed rooms

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Elements from transportation and industrial sources were measured indoors and out in various rooms. An experimental room was designed to measure filtration through walls, deposition on walls, and resuspension from room surfaces. The model found indoor exposure to these pollutants was no more than 1/3 of expected outdoor exposure over the same time period.

# I. CHARACTERIZATION AND MEASUREMENT

B1. Indoor-Outdoor Relationships: Fixed site  
(continued)

14. Bellin, P. and J. D. Spengler. 1980. Indoor and outdoor carbon monoxide measurements at an airport. JAPCA 30(4):309-394. [A, F]

Investigator: Harvard School of Public Health

Sponsor: NA

Pollutants Measured: CO.

Pollutant Sources: NA

Premises: airport

Geographical Location: Boston, MA

Season: winter, 1978

Ventilation Rates: NA

Major Findings: Indoor/outdoor carbon monoxide measurements were taken at Logan International Airport. Indoor concentrations were found to be lower than outdoor concentrations. The carbon monoxide levels do not constitute a health threat to the general public or the working population.

15. Biersteker, K. 1982. Indoor-outdoor air quality relationships: Discussion. JAPCA 32(9):908-913. [A, C, F]

Investigator: K. Biersteker

Sponsor: NA

Pollutants Measured: NA

Pollutant Sources: NA

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Biersteker reviews indoor air quality problems in the Netherlands with regard to health effects and indoor/outdoor relationships of SO<sub>2</sub>, CO, and NO<sub>2</sub>. Both historical and recent data are summarized.

## I. CHARACTERIZATION AND MEASUREMENT

### B1. Indoor-Outdoor Relationships: Fixed site (continued)

16. Colome, S. D., J. D. Spengler, and S. McCarthy. 1982. Comparisons of element and inorganic compounds inside and outside of residences. Environment International 8:197-212. [A, F]

Investigator: Harvard School of Public Health

Sponsor: NIEHS; EPRI; EPA

Pollutants Measured: SO<sub>2</sub>; NO<sub>2</sub>; respirable particles

Pollutant Sources: NA

Premises: 10 houses

Geographical Location: Steubenville, OH; Portage; WI

Season: year-round

Ventilation Rates: NA

Major Findings: Results of more than one year of air monitoring inside and outside of five homes in each of two communities are presented for SO<sub>2</sub>, NO<sub>2</sub>, respirable particles, SO<sub>4</sub>, Al, Br, Cl, Mn, Na, and V. Outdoor levels across the home site in each city are consistent with proximity to outdoor sources. Indoor levels of SO<sub>2</sub>, SO<sub>4</sub>, Mn, and V are lower than those measured outdoors.

17. Halpern, M. 1978. Indoor/outdoor air-pollution exposure continuity relationships. JAPCA 28(7):689-691. [A, F]

Investigator: City University of New York, School of Health Sciences

Sponsor: New York Lung Association

Pollutants Measured: respirable particulate lead

Pollutant Sources: NA

Premises: 2 apartments and a museum

Geographical Location: New York City

Season: Aug, Oct (1974)

Ventilation Rates: NA

Major Findings: Indoor/outdoor respirable particulate lead measurements were made using a stacked filter sampler. Indoor respirable lead values tended to be lower than outdoor levels. Significant differences were observed for indoor lead levels between air conditioned and non-air conditioned sites.

## I. CHARACTERIZATION AND MEASUREMENT

### B1. Indoor-Outdoor Relationships: Fixed site (continued)

18. Howlett, Jr., C. T. 1982. Indoor-outdoor air quality relationships: Discussion. JAPCA 32(9):913-916. [D]

Investigator: NA  
Sponsor: NA  
Pollutants Measured: NA  
Pollutant Sources: NA  
Premises: NA  
Geographical Location: NA  
Season: NA  
Ventilation Rates: NA

Major Findings: Reviewing J. E. Yocum's article (entry 23), Howlett uses formaldehyde as a model for comparing what is known about indoor air quality and the potential adverse health effects. The problem of regulating indoor exposures must consider what is known about indoor air levels, what can be done to reduce exposure levels, and the role of building codes in limiting exposure.

19. Lannefors, H. and H. C. Hansson. 1981. Indoor/outdoor elemental concentration relationships at a nursery school. Nuclear Instruments and Methods 181:441-444. [A, F]

Investigator: Lund Institute of Technology  
Sponsor: NA  
Pollutants Measured: particulate lead and bromine  
Pollutant Sources: NA  
Premises: nursery school  
Geographical Location: Lund, Sweden  
Season: August 1978  
Ventilation Rates: 0.5-1.0 ach

Major Findings: Indoor and outdoor concentrations of lead and bromine at a nursery school were measured using streaker samplers. Observed variation in concentration correlated well with traffic intensity variations. The indoor concentrations of the elements studied were about one-fifth of outdoor levels.

I. CHARACTERIZATION AND MEASUREMENT

B1. Indoor-Outdoor Relationships: Fixed site  
(continued)

20. Moschandreas, D. J. 1982. Indoor-outdoor air quality relationships: Discussion. JAPCA 32(9):904-907. [F]

Investigator: Moschandreas, D.

Sponsor: NA

Pollutants Measured: NA

Pollutant Sources: NA

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Moschandreas reviews J. E. Yocum's paper on indoor-outdoor air quality relationships (entry 23) and specifically addresses the limitations and contributions of his I/O ratio. Mr. Moschandreas feels that adequate work has been done on characterization of U.S. housing and that efforts should be directed towards IAQ model formulation, validation and proper use.

21. Spengler, J. D. 1982. Indoor-outdoor air quality relationships: Discussion. JAPCA 32(9):907-909. [D]

Investigator: J. D. Spengler

Sponsor: NA

Pollutants Measured: NA

Pollutant Sources: NA

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Spengler reviews J. E. Yocum's paper on indoor-outdoor air quality relationships (entry 23) and notes that Yocum has not critically reviewed published data. Spengler discusses the contribution of indoor pollutants to health effects, the areas where more research is needed, and some possible governmental initiatives.



## I. CHARACTERIZATION AND MEASUREMENT

### B1. Indoor-Outdoor Relationships: Fixed site (continued)

22. Spengler, J. D., C. P. Duffy, R. Letz, T. W. Tibbitts, and B. G. Ferris, Jr. 1983. Nitrogen dioxide inside and outside 137 homes and implications for ambient air quality standards and health effects research. Environmental Science and Technology 17(3):164-168.

Investigator: Harvard School of Public Health; Univ. of Wisconsin

Sponsor: Wisconsin Power Companies; EPRI; NIEHS

Pollutants Measured: NO<sub>2</sub>

Pollutant Sources: gas stoves

Premises: 137 homes

Geographical Location: Portage, WI

Season: year-round

Ventilation Rates: NA

Major Findings: Annual mean ambient concentration of NO<sub>2</sub> was 10-15 µg/m<sup>3</sup>, while homes with gas ranges averaged 50 µg/m<sup>3</sup> higher in the kitchen and 30 µg/m<sup>3</sup> higher in bedroom. Electric stoves did not contribute to indoor NO<sub>2</sub> and levels were 1/2 to 2/3 of ambient levels. No predictive models were developed due to large variations of NO<sub>2</sub> concentrations in homes--most likely due to differences in stove use, emission rates, and air exchange rates.

23. Yocum, J. E. 1982. Indoor-outdoor air quality relationships: A critical review. JAPCA 32(5):500-520. [A, F]

Investigator: TRC Environmental Consultants, Inc.

Sponsor: NA

Pollutants Measured: NA

Pollutant Sources: NA

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: This is a critical review article in which the implications and shortcomings of key research efforts are discussed. A useful grouping of air pollutants by source (predominantly outdoor, both indoor and outdoor, and predominantly outdoor) provides the basis for reviewing indoor-outdoor air quality relationships.

## I. CHARACTERIZATION AND MEASUREMENT

### B2. Indoor-Outdoor Relationships: Exposure monitoring

24. Dockery, D. and J. D. Spengler. 1981. Personal exposure to respirable particulates and sulfates. JAPCA 31(2):153-159. [A, F]

Investigator: Harvard School of Public Health

Sponsor: NIEHS; EPRI

Pollutants Measured: respirable particles and sulfates

Pollutant Sources: NA

Premises: indoor (homes); outdoor; personal

Geographical Location: Watertown; MA; Steubenville, OH

Season: summer and winter

Ventilation Rates: NA

Major Findings: Personal exposure to respirable particles and sulfates were measured in Watertown, MA and Steubenville, OH. Mean personal exposure for each city was related to mean outdoor levels for the city. A time-weighted indoor/outdoor activity model only modestly improved estimates of personal exposure over those predicted from measured indoor concentrations alone.

25. Nitta, H. and K. Maeda. 1982. Personal exposure monitoring to nitrogen dioxide. Environment International 8:243-248. [A, F]

Investigator: University of Tokyo

Sponsor: Tokyo Foundation and Ministry of Education, Science, and Culture

Pollutants Measured: NO<sub>2</sub>

Pollutant Sources: NA

Premises: houses, offices

Geographical Location: Tokyo, Japan

Season: summer and winter

Ventilation Rates: NA

Major Findings: Indoor, outdoor, and personal exposure measurements of NO<sub>2</sub> were made in a number of houses and offices in different seasons. Unvented space heaters were found to increase personal exposure. A time-weighted indoor/outdoor activity model gives modestly improved estimates of personal exposure over those predicted from indoor concentrations alone.

## I. CHARACTERIZATION AND MEASUREMENT

### 82. Indoor-Outdoor Relationships: Exposure monitoring (continued)

26. Ott, W. and P. Flachsbart. 1982. Measurement of carbon monoxide concentrations in indoor and outdoor locations using personal exposure monitors. Environment International 8:295-304. [A, F]

Investigator: Univ. of Hawaii

Sponsor: EPA

Pollutants Measured: CO

Pollutant Sources: NA

Premises: commercial settings

Geographical Location: California cities

Season: Nov 1979-June 1980

Ventilation Rates: NA

Major Findings: Personal exposure monitoring measurements for CO were made in four California cities (San Francisco, Palo Alto, Mountain View, and Los Angeles). Most commercial settings had CO concentrations above zero, because CO tends to seep into buildings from outside vehicular emissions. Indoor garages and buildings with attached parking garages can experience relatively high CO levels.

27. Segal, K. and M. Fugas. 1982. Personal exposure versus monitoring station data for respirable particles. Environment International 8:259-263. [A, F]

Investigator: Inst. for Medical Research and Occupational Health, Zagreb, Yugoslavia

Sponsor: WHO; Research Council of Croatia

Pollutants Measured: respirable and total suspended particles

Pollutant Sources: NA

Premises: NA

Geographical Location: Zagreb, Yugoslavia

Season: Dec 1980-Mar 1981

Ventilation Rates: NA

Major Findings: Twelve subjects working at the same location, but living in various parts of Zagreb, were monitored for 7 consecutive days for personal exposure to respirable particles. These data were compared with simultaneously obtained data from the outdoor network station nearest to subject's home. The ratio between average personal exposure and respirable particle levels in the outdoor air decreases with the increased outdoor concentration; thus, this relationship might serve as the basis for rough estimations of personal exposure.

## I. CHARACTERIZATION AND MEASUREMENT

### B2. Indoor-Outdoor Relationships: Exposure monitoring (continued)

28. Silverman, F., P. Corey, S. Mintz, P. Olver, and R. Hosein. 1982. A study of effects of ambient urban air pollution using personal samplers: A preliminary report. Environment International 8:311-316. [A, F]

Investigator: Gage Research Institute, Univ. of Toronto

Sponsor: WHO; York-Toronto Lung Association

Pollutants Measured: Suspended particles; SO<sub>2</sub>; NO<sub>2</sub>

Pollutant Sources: NA

Premises: homes

Geographical Location: Toronto, Canada

Season: heating/nonheating seasons

Ventilation Rates: NA

Major Findings: This study was conducted using a control and an asthmatic group in which effects of air pollution were assessed by symptom, medication diary, and pulmonary function tests. Air pollution exposure was measured using small portable samplers for particles, SO<sub>2</sub>, and NO<sub>2</sub>. These samplers were carried by subjects and situated inside and outside homes. Results suggest the need for using personal samplers when investigating health effects.

29. Tosteson, T. D., J. D. Spengler, and R. A. Weker. 1982. Aluminum, iron, and lead content of respirable particulate samples from a personal monitoring study. Environment International 8:265-268. [A, F]

Investigator: Harvard School of Public Health

Sponsor: EPA; EPRI; NIEHS

Pollutants Measured: respirable particles

Pollutant Sources: NA

Premises: indoor (24 homes); outdoor; personal

Geographical Location: Topeka, KS

Season: Spring, 1979

Ventilation Rates: NA

Major Findings: Samples of respirable particulate matter collected during a personal monitoring study in Topeka, KS, were analyzed for iron, aluminum, and lead. Indoor, outdoor, and personal levels of iron and aluminum were not significantly different. Indoor lead concentrations were found to be less than both personal and outdoor levels.



## I. CHARACTERIZATION AND MEASUREMENT

### B2. Indoor-Outdoor Relationships: Exposure monitoring (continued)

30. Wallace, L., R. Zweidinger, M. Erickson, S. Cooper, D. Whitaker, and E. Pellizzari. 1982. Monitoring individual exposure: Measurements of volatile organic compounds in breathing-zone air, drinking water, and exhaled breath. Environment International 8:269-282. [A, B, F]

Investigator: RTI

Sponsor: EPA

Pollutants Measured: volatile organics

Pollutant Sources: NA

Premises: varied

Geographical Location: TX, NC

Season: summer 1980

Ventilation Rates: NA

Major Findings: Personal exposure of students to volatile organics in Chapel Hill, NC and Beaumont, TX were assessed using exposure monitors, water samples, and breath analysis. Air exposure to volatile organics varied widely even among students on the same campus. Air was the main route of exposure for all target compounds except two trihalomethanes which were transmitted through water.

31. Ziskind, R. A., K. Fite, and D. T. Mage. 1982. Pilot field study: Carbon monoxide exposure monitoring in the general population. Environment International 8:283-293. [A, F]

Investigator: Science Applications, Inc., Los Angeles, CA.

Sponsor: EPA

Pollutants Measured: CO

Pollutant Sources: NA

Premises: varied

Geographical Location: Los Angeles, CA

Season: NA

Ventilation Rates: NA

Major Findings: A pilot field study enlisted nine people to measure carbon monoxide by using personal monitors. The 9 ppm ambient air quality standard was exceeded on 22 person days. Elevated carbon monoxide concentrations during commuting activity were frequently associated with the exceedances.



I. CHARACTERIZATION AND MEASUREMENT

C1. Gaseous Pollutants: Inorganics

32. Good, D. W., G. Vilcins, W. R. Harvey, D. A. Clabo, Jr., and A. L. Lewis. 1982. Effect of cigarette smoking on residential NO<sub>2</sub> levels. Environment International 8:167-175. [A, F]

Investigator: Philip Morris, Inc.

Sponsor: Philip Morris, Inc.

Pollutants Measured: NO<sub>2</sub>

Pollutant Sources: gas appliances, smoking

Premises: homes

Geographical Location: Richmond, VA

Season: summer 1980 and winter 1981

Ventilation Rates: NA

Major Findings: Gas-fired kitchen appliances were found to account for the largest increases in indoor NO<sub>2</sub> levels. Non-smokers were classified as those smoking less than 20 cigarettes per week.

33. Jaeger, R. J. 1981. Carbon monoxide in houses and vehicles. Bulletin New York Academy Medicine 57(10):860-872. [C, F]

Investigator: N.Y.U. Medical Center

Sponsor: NIEHS

Pollutants Measured: CO

Pollutant Sources: natural gas combustion, tobacco smoke

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: This is a survey and literature review presented at a Symposium on the Health Aspects of Indoor Air Pollution, NY Academy of Medicine, May 1981. Health issues and potential sources of carbon monoxide are discussed.

I. CHARACTERIZATION AND MEASUREMENT

Cl. Gaseous Pollutants: Inorganics  
(continued)

34. Lundqvist, G. R., M. Iversen, and J. Korsgaard. 1982. Indoor climate in low-ventilated day-care institutions. Environment International 8:139-142. [A, F]

Investigator: Univ. of Aarhus, Inst. of Hygiene, Denmark

Sponsor: NA

Pollutants Measured: CO<sub>2</sub>, water vapor

Pollutant Sources: humans

Premises: day-care nursery, kindergarten

Geographical Location: Denmark

Season: NA

Ventilation Rates: 1-2 m<sup>3</sup> fresh air/person/h

Major Findings: Exposure conditions in the field were duplicated under controlled conditions. The results showed that CO<sub>2</sub> concentrations reached 3,500 to 4,000 ppm, whereas background is 350 ppm. Water vapor reached 8-10 g/kg of dry air. The CO<sub>2</sub> levels were unacceptable by WHO standards. Building codes should be designed to control CO<sub>2</sub> buildup where ventilation is low.

35. Moschandreas, D. J. and J. Zabransky, Jr. 1982. Spatial variation of carbon monoxide and oxides of nitrogen concentrations inside residences. Environment International 8:177-183. [A, F]

Investigator: IITRI; Geomet Technologies, Inc.

Sponsor: NA

Pollutants Measured: NO, NO<sub>2</sub>, CO

Pollutant Sources: NA

Premises: 12 residences, 2 office buildings

Geographical Location: Boston, MA

Season: NA

Ventilation Rates: 0.5-1.2 ach

Major Findings: Concentrations of combustion gases vary from room to room in buildings using gas-cooking appliances, but not in residences with electric appliances. The magnitude of the difference is not large. More than single-zone sampling is recommended, although one indoor zone adequately characterizes the environment if sampling is done continuously.

## I. CHARACTERIZATION AND MEASUREMENT

### C1. Gaseous Pollutants: Inorganics (continued)

36. Quackenboss, J. J., M. S. Kanarek, J. D. Spengler, and R. Letz. 1982. Personal monitoring for nitrogen dioxide exposure: Methodological considerations for a community study. Environment International 8:249-258. [A, F]

Investigator: Harvard School of Public Health  
Sponsor: Wisconsin Power and Light Co.; EPA  
Pollutants Measured: NO<sub>2</sub>  
Pollutant Sources: NA  
Premises: 19 homes  
Geographical Location: Portage, WI  
Season: March 1981  
Ventilation Rates: NA

Major Findings: Passive diffusion NO<sub>2</sub> monitors were placed outdoors, in the kitchen, in one bedroom on each floor of homes, and worn by family members. Individuals from gas-cooking homes had significantly higher average NO<sub>2</sub> exposures than those from homes using electricity for cooking. Personal exposures were more closely related to bedroom levels than to kitchen or outdoor concentrations for both cooking fuel groups. Several preliminary models are presented which relate average personal NO<sub>2</sub> exposure to indoor and ambient levels, and also to the proportion of time spent in different locations.

37. Selway, M. D., R. J. Allen, and R. A. Wadden. 1980. Ozone production from photocopying machines. American Industrial Hygiene Association Journal 41:455-459. [A,F]

Investigator: Univ. of Illinois, School of Public Health  
Sponsor: NIOSH  
Pollutants Measured: ozone  
Pollutant Sources: photocopying machines  
Premises: sealed rooms  
Geographical Location: NA  
Season: NA  
Ventilation Rates: NA

Major Findings: Ten photocopying machines operating in sealed rooms were sampled for ozone emissions. All but one model produced detectable amounts. Emission rates of <1 to 54 µg/copy were found. Servicing the machines reduced emissions to <1-4 µg/copy, but preservicing levels returned after several weeks of operation.

I. CHARACTERIZATION AND MEASUREMENT

Cl. Gaseous Pollutants: Inorganics  
(continued)

38. Wallace, L. A. 1983. Carbon monoxide in air and breath of employees in an underground office. JAPCA 33(7):678-682. [A, C, E, F]

Investigator: EPA

Sponsor: EPA

Pollutants Measured: CO

Pollutant Sources: parking garage

Premises: office building

Geographical Location: NA

Season: February

Ventilation Rates: NA

Major Findings: Elevated carbon monoxide levels were found in the air and lungs of workers in an underground office that was connected to a parking garage. Closing fire doors and activating parking garage fans rectified the situation. The methods and equipment employed in this study are recommended for identifying similar carbon monoxide problems.

39. Yanagisawa, Y., and H. Nishimura. 1982. A badge-type personal sampler for measurement of personal exposure to NO<sub>2</sub> and NO in ambient air. Environment International 8:235-242. [B]

Investigator: Univ. of Tokyo, Dept. of Chemical Engineering

Sponsor: NA

Pollutants Measured: NO, NO<sub>2</sub>

Pollutant Sources: NA

Premises: laboratory

Geographical Location: Tokyo, Japan

Season: NA

Ventilation Rates: velocity: 0.15-4.0 m/s

Major Findings: A badge-type sampler was developed for monitoring personal exposure to NO<sub>2</sub>. The sampler measured NO<sub>2</sub> concentration within an accuracy of  $\pm 20\%$ . The lower limit for reliable measurement is 66 ppbh. NO is measured by providing an oxidation layer in the filter.

## I. CHARACTERIZATION AND MEASUREMENT

### C2. Gaseous Pollutants: Organics

40. Berglund, B., I. Johansson, and T. Lindvall. 1982. A longitudinal study of air contaminants in a newly built preschool. Environment International 8:111-115. [A, E, F]

Investigator: Univ. of Stockholm

Sponsor: Swedish Council for Building Research

Pollutants Measured: volatile organics

Pollutant Sources: NA

Premises: preschool

Geographical Location: Stockholm, Sweden

Season: NA

Ventilation Rates: 81-91% recirculation

Major Findings: Typical air contaminants emanating from building materials were determined, their variation over time was measured, and the influence of the ventilation system on contaminant concentrations was studied. The concentrations of 22 organic compounds were far below occupational threshold limit values. All organic compounds declined over time, mainly within six months. The authors suggest a six-month "gassing-off" period with no recirculation.

41. Dally, K. A., L. P. Hanrahan, M. A. Woodbury, and M. S. Kanarek. 1981. Formaldehyde exposure in nonoccupational environments. Archives of Environmental Health 36:277-284. [A, C]

Investigator: Wisconsin Division of Health

Sponsor: EPA

Pollutants Measured: formaldehyde

Pollutant Sources: building materials

Premises: homes

Geographical Location: Madison, Wisconsin

Season: year-round

Ventilation Rates: NA

Major Findings: Air samples were collected in 100 structures, primarily mobile homes. An association was found between formaldehyde level and age of building materials. Health effects were eye irritation, runny nose, dry or sore throats, headache and cough. The authors suggest that nonoccupational indoor environmental exposure to formaldehyde is significant and may exceed the standard set for occupational exposure.



I. CHARACTERIZATION AND MEASUREMENT

C2. Gaseous Pollutants: Organics  
(continued)

42. Eckmann, A. D., K. A. Dally, L. P. Hanrahan, and H. A. Anderson. 1982. Comparison of the chromotropic acid and modified pararosaniline methods for the determination of formaldehyde in air. Environment International 8:159-166. [A, B]

Investigator: Wisconsin Div. of Health  
Sponsor: EPA; State of Wisconsin  
Pollutants Measured: formaldehyde  
Pollutant Sources: homes, building materials  
Premises: 25 homes; 14 mobile homes  
Geographical Location: Wisconsin  
Season: spring  
Ventilation Rates: NA

Major Findings: Ambient formaldehyde concentrations were measured using four sampling trains and two analytical methods. Analysis of variance indicated little difference among the sampling trains. Good agreement was found between chromotropic acid and pararosaniline analytical methods although the modified pararosaniline method produced lower values for field samples than the chromotropic acid method; a source of interference was postulated.

43. Garry, V. F., L. Oatman, R. Pleus, and D. Gray. 1980. Formaldehyde in the home. Minnesota Medicine 63(2):107-111. [A, C, F]

Investigator: Minnesota Dept of Health, Univ. of Minnesota  
Sponsor: Minnesota State Planning Agency  
Pollutants Measured: formaldehyde  
Pollutant Sources: NA  
Premises: homes  
Geographical Location: Minnesota  
Season: winter-spring-summer  
Ventilation Rates: NA

Major Findings: Formaldehyde levels were found to be significantly higher in homes of persons with symptoms than those without symptoms. Asthmatics are more sensitive and smokers less sensitive to formaldehyde exposure. Newer mobile homes showed higher levels of formaldehyde.

## I. CHARACTERIZATION AND MEASUREMENT

### C2. Gaseous Pollutants: Organics (continued)

44. Geisling, K. L., M. K. Tashima, J. R. Girman, R. R. Miksch, and S. M. Rappaport. 1982. A passive sampling device for determining formaldehyde in indoor air. Environment International 8:153-158. [B]

Investigator: LBL; Univ. of California, Berkeley

Sponsor: DOE; California Energy Commission

Pollutants Measured: formaldehyde

Pollutant Sources: NA

Premises: laboratory

Geographical Location: Berkeley, CA

Season: NA

Ventilation Rates: NA

Major Findings: A passive sampler was developed with  $\text{NaHSO}_3$  (sodium sulfite) soaked glass-fiber filters. In the field, the device collects a sample by being uncapped for a specified time. Recapped, it is returned to the laboratory and the filter analyzed by the chromotropic acid method. It is a simple, sensitive device that shows excellent storage characteristics.

45. Godish, T. 1981. Formaldehyde and building-related illness. Journal of Environmental Health 44(3):116-121. [A, C]

Investigator: Ball State Univ.

Sponsor: NA

Pollutants Measured: formaldehyde

Pollutant Sources: NA

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: This is a review article covering monitoring, health effects, formaldehyde sources, and cause-effect relationships. There is an apparent causal relationship between building-related formaldehyde exposure and symptoms, although definitive epidemiological studies are needed.

## I. CHARACTERIZATION AND MEASUREMENT

### C2. Gaseous Pollutants: Organics (continued)

46. Hollowell, C. D., and R. R. Miksch. 1981. Sources and concentrations of organic compounds in indoor environments. Bulletin New York Academy Medicine 57(10):962-977. [A, F]

Investigator: LBL

Sponsor: DOE

Pollutants Measured: organics

Pollutant Sources: NA

Premises: Office buildings, mobile homes

Geographical Location: varied

Season: NA

Ventilation Rates: NA

Major Findings: Summaries of formaldehyde and other organic compound concentrations measured in office buildings and a few mobile homes are presented. The authors emphasize the variety of organic compounds found in typical office spaces.

47. Jarke, F. H., A. Dravnieks, and S. M. Gordon. 1981. Organic contaminants in indoor air and their relation to outdoor contaminants. ASHRAE Transactions 87(1):153-166. [A, F]

Investigator: IITRI, Chicago, IL

Sponsor: ASHRAE

Pollutants Measured: organics

Pollutant Sources: NA

Premises: homes

Geographical Location: Washington, DC, Chicago IL

Season: winter/summer

Ventilation Rates: NA

Major Findings: Concentration of organics are on average, at or below 100 ppb. Indoor activities such as painting, varnishing, cleaning and cooling can produce higher levels. The number of compounds found indoors was higher than outdoors, both winter and summer. Nearby industrial operations have a slight effect on contaminants found in the homes.

## I. CHARACTERIZATION AND MEASUREMENT

### C2. Gaseous Pollutants: Organics (continued)

48. Livingston, J. M. and C. R. Jones. 1981. Living area contamination by chlordane used for termite treatment. Bulletin Environmental Contamination Toxicology 27:406-411. [A, F]

Investigator: Air Force Medical Research Lab.

Sponsor: U.S. Air Force

Pollutants Measured: Chlordane

Pollutant Sources: pest control

Premises: apartments, homes

Geographical Location: NA

Season: all

Ventilation Rates: NA

Major Findings: An investigation of chlorodane-treated residences showed that weather parameters had no apparent effect on chlordane concentration and no degradation was found over time. Higher concentrations were found for apartments treated in two specific years, implying faculty application of the pesticide. Ducting found in residence slabs will continue to generate chlordane when termite treatment is performed.

49. MacLeod, K. E. 1981. Polychlorinated biphenyls in indoor air. Environmental Science & Technology 15(8):926-928. [A, B, F]

Investigator: HERL (EPA)

Sponsor: EPA

Pollutants Measured: PCBs

Pollutant Sources: NA

Premises: laboratories; offices; homes

Geographical Location: NA

Season: Various

Ventilation Rates: NA

Major Findings: This paper describes a method for sampling and analyzing PCB's using low-volume air sampling through polyurethane foam collectors. "Normal" levels of PCBs found in indoor air are at least 10 times higher than outdoor levels. Kitchens showed highest levels of PCB in homes.

I. CHARACTERIZATION AND MEASUREMENT

C2. Gaseous Pollutants: Organics  
(continued)

50. Matthews, T. G., A. R. Hawthorne, T. C. Howell, C. E. Metcalfe, and R. B. Gammage. 1982. Evaluation of selected monitoring methods for formaldehyde in domestic environments. Environment International 8:143-151. [B]

Investigator: ORNL, Health and Safety Research Division

Sponsor: DOE; CPSC

Pollutants Measured: formaldehyde

Pollutant Sources: NA

Premises: homes

Geographical Location: NA

Season: Winter

Ventilation Rates: NA

Major Findings: Four methods for monitoring formaldehyde were evaluated in controlled tests: (1) The CEA Instruments, Inc. (model 555) wet chemical analyzer for indoor air monitoring; (2) a molecular sieve suitable for rapid sampling applications; (3) a passive semipermeable membrane sampler providing integrated exposure measurement; and (4) a visual colorimetric analysis, used in conjunction with passive samplers.

51. Miksch, R. R., C. D. Hollowell, L. Z. Fanning, A. Newton, and H. Schmidt. 1980. Trace organic contaminants in indoor air environments. American Chemical Society, Division of Environmental Chemistry Preprints 20(2): 57-60. [A, B, F]

Investigator: LBL

Sponsor: NA

Pollutants Measured: organics

Pollutant Sources: NA

Premises: trailers, offices

Geographical Location: Berkeley and San Francisco, CA

Season: NA

Ventilation Rates: NA

Major Findings: Internal standards were dissolved in tetradecane for a fast, simple reproducible standardization method. Organics were found to be higher indoors than outside and many of the compounds have been identified by OSHA, EPA, and NIOSH as potentially hazardous (not at the levels measured here.)



## I. CHARACTERIZATION AND MEASUREMENT

### C2. Gaseous Pollutants: Organics (continued)

52. Miksch, R. R., C. D. Hollowell, and H. E. Schmidt. 1982. Trace organic chemical contaminants in office spaces. Environment International 8:129-137. [A, E, F]

Investigator: LBL  
Sponsor: DOE  
Pollutants Measured: organics  
Pollutant Sources: varied  
Premises: offices  
Geographical Location: Berkeley, CA  
Season: NA  
Ventilation Rates: NA

Major Findings: Levels of indoor pollutants are higher than outdoor ambient levels but  $10^2$  to  $10^4$  times lower than occupational standards. The impacts of building materials are not well defined or understood, but "drying out" periods for new construction may be a good idea. Controlling office pollutants at the source is more efficient than increasing ventilation rates.

53. Mølhave, L. 1982. Indoor air pollution due to organic gases and vapours of solvents in building materials. Environment International 8:117-127. [A, C, F]

Investigator: Univ. of Aarhus, Denmark  
Sponsor: Danish National Health Foundation  
Pollutants Measured: organics compounds from solvents  
Pollutant Sources: 42 commonly used building material  
Premises: laboratory  
Geographical Location: Aarhus, Denmark  
Season: NA  
Ventilation Rates: NA

Major Findings: Testing facilities are suitable for classification of emissions from building materials. Mathematical models correlated well with actual measured concentrations found in model rooms. Potential health risks exist, especially for sensitive individuals.

## I. CHARACTERIZATION AND MEASUREMENT

### C2. Gaseous Pollutants: Organics (continued).

54. Oblas, D. W., D. L. Dugger, and S. I. Lieberman. 1980. The determination of organic species in the telephone central office ambience. IEEE: Transactions on Components, Hybrids, and Manufacturing Technology 3(1):17-20. [A, F]

Investigator: GTE Laboratories, Inc.

Sponsor: GTE Labs

Pollutants Measured: organics

Pollutant Sources: NA

Premises: offices

Geographical Location: 5 cities

Season: winter, summer

Ventilation Rates: NA

Major Findings: Organics known to interfere or effect electrical components were sampled at five telephone offices across the United States. Values ranged from 1 to 100 ppb. Halo-hydrocarbons originate in contact cleaners, lubricants and spray cans, however outside sources are significant for certain organics.

55. Wang, T. C. 1975. A study of bioeffluents in a college classroom. ASHRAE Transactions 81(1):32-44. [A, F]

Investigator: Harbor Branch Foundation Lab, Florida

Sponsor: ASHRAE

Pollutants Measured: organics,  $\text{NH}_3$ ,  $\text{H}_2\text{S}$ ,  $\text{CO}_2$ , CO

Pollutant Sources: human

Premises: college auditorium

Geographical Location: Iowa City, Iowa

Season: NA

Ventilation Rates: NA

Major Findings: Using a mass balance model,  $\text{CO}_2$  was found to be the most abundant inorganic compound generated in the classroom. Methanol, ethanol, and acetone were found to be highest among organics. Variation was found for different times of the day, and slightly from day to day, except during exams when  $\text{CO}_2$  was found to be 45% higher.

## I. CHARACTERIZATION AND MEASUREMENT

### D. Radon

56. Abu-Jarad, F. and J. H. Fremlin. 1982. The activity of radon daughters in high-rise buildings and the influence of soil emanation. Environment International 8:37-43. [A, F]

Investigator: Univ. of Petroleum and Minerals, Saudi Arabia

Sponsor: NA

Pollutants Measured: radon

Pollutant Sources: NA

Premises: high rise buildings

Geographical Location: Birmingham, England

Season: Summer, fall, winter

Ventilation Rates: 0.1-1.4 ach

Major Findings: Radon levels are most strongly correlated with floor construction and subfloor ventilation. Ventilation strongly influences radon exposure. However, ground floor residences show higher activity whether in single homes or high-rise buildings.

57. Bruno, R. C. 1983. Sources of indoor radon in houses: A review. JAPCA 33(2):105-109. [A, E, F]

Investigator: EPA, Office of Radiation Programs

Sponsor: NA

Pollutants Measured: radon

Pollutant Sources: varied

Premises: homes

Geographical Location: varied

Season: NA

Ventilation Rates: 1 ach (input)

Major Findings: Based on a mass balance model, governmental guidelines will be exceeded in regions with high radon soil levels. The best controls are sealing of cracks, rather than impermeable coatings on slabs and foundation walls. New construction techniques can reduce radon exposure without significant cost increases. Air tight homes (0.1 to 0.2 ach) present particular problems.

## I. CHARACTERIZATION AND MEASUREMENT

### D. Radon (continued)

58. Fleischer, R. L., W. R. Giard, A. Mogro-Campero, L. G. Turner, H.W. Alter, and J. E. Gingrich. 1980. Dosimetry of environmental radon: Methods and theory for low-dose, integrated measurements. Health Physics 39:957-962. [A, B]

Investigator: General Electric Research and Development Center

Sponsor: GE

Pollutants Measured: radon

Pollutant Sources: NA

Premises: homes

Geographical Location: Schenectady, NY

Season: NA

Ventilation Rates: NA

Major Findings: A theoretical discussion of radon detection is followed by laboratory and field testing of Track-Etch<sup>®</sup> dosimeter cups. A high degree of linearity was shown between machine readings (track density) and integrated concentrations from controlled exposure chambers. Field testing in basements and first floors gave representative results.

59. Hernandez, T., and J. W. Ring. 1982. Indoor radon source-fluxes: Experimental tests of a two-chamber model. Environment International 8:45-57. [A, F]

Investigator: Princeton University

Sponsor: DOE

Pollutants Measured: radon

Pollutant Sources: NA

Premises: homes

Geographical Location: Princeton, NJ

Season: spring, summer

Ventilation Rates: 0.26-1.96 ach

Major Findings: A two-chamber model, involving both living area and basement radon levels, was far superior to a single chamber (basement) model in predicting total indoor radon exposure. A one chamber model underestimates the radon source flux (pCi/min).

## I. CHARACTERIZATION AND MEASUREMENT

### D. Radon (continued)

60. Hess, C. T., C. V. Weiffenbach, and S. A. Norton. 1982. Variations of airborne and waterborne Rn-222 in houses in Maine. Environment International 8:59-66. [A, F]

Investigator: Univ. of Maine  
Sponsor: NA  
Pollutants Measured: radon  
Pollutant Sources: well water  
Premises: homes  
Geographical Location: Maine  
Season: Fall, winter, spring  
Ventilation Rates: 0.3-2.0 ach

Major Findings: Radon levels found in the homes were at the level at which action is recommended (3 pCi/L). Air levels correlated well with water levels, showing 1.07 pCi Rn/L in air per 10,000 pCi Rn/L of water. Increased water use in the home (shower, clothes and dishwashing) raised air levels. Health risks are suggested by the correlation of water radon levels with lung cancer in 16 Maine counties.

61. Hildingson, O. 1982. Radon measurements in 12,000 Swedish homes. Environment International 8:67-70. [A, C, F]

Investigator: Swedish National Testing Institute  
Sponsor: Swedish National Testing Institute  
Pollutants Measured: radon  
Pollutant Sources: NA  
Premises: homes, apartments  
Geographical Location: Sweden  
Season: annual  
Ventilation Rates: NA

Major Findings: Homes having greatest contact with soils showed higher rates of radon levels (above 10 pCi/L). Many of homes in Sweden had such high radon levels and 10,000 homes (with >27 pCi/L) must be rebuilt according to government limits.



## I. CHARACTERIZATION AND MEASUREMENT

### D. Radon (continued)

62. Jonassen, N. 1981. Indoor radon concentrations and building materials control of airborne radioactivity. In Building Energy Management, edited by Fernandes Olivia, 695-701. London: Oxford Press. [A, C, F]  
Investigator: Technical University of Denmark  
Sponsor: Technical University of Denmark  
Pollutants Measured: radon  
Pollutant Sources: NA  
Premises: basement room  
Geographical Location: Denmark  
Season: NA  
Ventilation Rates: varied  
  
Major Findings: Exhalation rates for various buildings materials are presented. Control measures are discussed. Limited experiments with circulation and filtration indicate that at a rate of  $1-2 \text{ h}^{-1}$  through an ordinary filter, radon daughter levels may be reduced by a factor of 5-10.
63. Jonassen, N., and J. P. McLaughlin. 1982. Air filtration and radon daughter levels. Environment International 8:71-75. [E, F]  
Investigator: Technical Univ. of Denmark  
Sponsor: NA  
Pollutants Measured: radon and daughters  
Pollutant Sources: walls, soils  
Premises: experimental room  
Geographical Location: Lyngby, Denmark  
Season: NA  
Ventilation Rates: 0.5-2.0 ach  
  
Major Findings: This paper investigates the effect of filtration and aerosol concentration on the level of short-lived airborne radon daughter products. Using an experimental chamber ( $324 \text{ m}^3$ ), it was found that at high aerosol concentrations, the decrease in daughter products could be explained simply as the effect of the filter removing the products. But as aerosol concentrations were lowered, daughter products increasingly plated out on the walls.

## I. CHARACTERIZATION AND MEASUREMENT

### D. Radon (continued)

64. Kusuda, T., S. Silberstein, and P. E. McNall, Jr. 1980. Modeling of radon and its daughter concentrations in ventilated spaces. JAPCA 30(11): 1201-1207. [E]

Investigator: National Bureau of Standards

Sponsor: NBS

Pollutants Measured: radon

Pollutant Sources: NA

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: A computer program (time-dependent model) based on ventilation, emanation rates, and sources, was developed to predict radon, daughters, and alpha levels. Air-tight homes (0.2 to 0.5 ach) contribute to levels that have been of concern.

65. Moschandreas, D. J., and H. E. Rector. 1982. Indoor radon concentrations. Environment International 8:77-82. [A, F]

Investigator: Geomet Technologies, Inc.

Sponsor: NA

Pollutants Measured: radon

Pollutant Sources: NA

Premises: homes

Geographical Location: Washington, DC suburb

Season: NA

Ventilation Rates: 0.06-1.57 ach

Major Findings: Fifty-five percent of all surveyed basements and 30% of all main floors showed levels in excess of 4.0 nCi/m<sup>3</sup>, a level that may be above EPA guidelines for homes built on land reclaimed from phosphate mines. Suburban levels were lower than town levels, but higher than rural. This is due either to differences in soil or construction practices.

## I. CHARACTERIZATION AND MEASUREMENT

### D. Radon (continued)

66. Prichard, H. M., T. F. Gesell, C. T. Hess, C. V. Weiffenbach, and P. Nyberg. 1982. Associations between grab sample and integrated radon measurements in dwellings in Maine and Texas. Environment International 8:83-87. [A]

Investigator: Univ. of Texas School of Public Health

Sponsor: EPA; NIEHS; NIH

Pollutants Measured: radon

Pollutant Sources: NA

Premises: homes

Geographical Location: Texas and Maine

Season: summer, winter

Ventilation Rates: NA

Major Findings: Log normal distributions were found for all locations, though geometric means varied. Grab samples are adequate for characterization of radon level in a geographical area, but integrated samples more adequately assess individual structures. Water sampling might also be useful in identifying geographic areas of concern.

## I. CHARACTERIZATION AND MEASUREMENT

### E. Consumer Products

67. Jackson, M. D., and R. G. Lewis. 1981. Insecticide concentrations in air after application of pest control strips. Bulletin of Environmental Contaminants Toxicology 27:122-125. [A]  
Investigator: EPA, Health Effects Research Lab  
Sponsor: EPA  
Pollutants Measured: 3 insecticides  
Pollutant Sources: pest control strips  
Premises: laboratory  
Geographical Location: North Carolina  
Season: NA  
Ventilation Rates: 8-10 ach  
  
Major Findings: There was a low level vaporization of insecticide from pest control strips, though no odor was detected. Highest air concentrations in a 30 m<sup>3</sup> room were 0.8, 1.4, and 0.25 µg/m<sup>3</sup> for propoxur, diazinon, and chlorpyrifos, respectively.
68. Mokler, B. V., B. A. Wong, and M. J. Snow. 1979. Respirable particulates generated by pressurized consumer products. I. Experimental method and general characteristics. American Industrial Hygiene Association Journal 40:330-338. [F]  
Investigator: Lovelace Biomedical and Environmental Research Institute  
Sponsor: DOE; CPSC; FDA  
Pollutants Measured: respirable particles  
Pollutant Sources: pressurized consumer products  
Premises: laboratory test chamber  
Geographical Location: NA  
Season: NA  
Ventilation Rates: NA  
  
Major Findings: Respirable particles are generated by pressurized consumer products. A simulated breathing zone model is developed and used to characterize these particles. There appears to be a nonlognormal size distribution with enrichment in the fine particulates that are deposited in the human respiratory tract.

## I. CHARACTERIZATION AND MEASUREMENT

### E. Consumer Products (continued)

69. Mokler, B. V., B. A. Wong, and M. J. Snow. 1979. Respirable particulates generated by pressurized consumer products. II. Influence of experimental conditions. American Industrial Hygiene Association Journal 40:339-348. [F]

Investigator: Lovelace Biomedical & Environmental Research Institute

Sponsor: DOE; CSPP; FDA

Pollutants Measured: respirable particles

Pollutant Sources: pressurized consumer products

Premises: laboratory test chamber

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Variation in experimental test chamber conditions had little effect on particle size characteristics. Data generated in the lab is the worst-case situation, in that actual exposure would be less than estimates based on this data.

70. Pickrell, J. A., B. V. Mokler, L. C. Griffis, C. H. Hobbs, and A. Bathija. 1983. Formaldehyde release rate coefficients from selected consumer products. Environmental Science and Technology 17(12):753-757. [F]

Investigator: Lovelace Biomedical & Environmental Research Institute

Sponsor: CPSC; DOE

Pollutants Measured: formaldehyde

Pollutant Sources: consumer/building products

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: A modified Japanese Industrial Standard dessicator procedure provided measurements of formaldehyde release from various consumer products (clothes, paper, fabric, carpet) and building materials (pressed wood, glass-fiber insulation). Release rate coefficients were calculated per unit mass and surface area for each product. Comparisons were made between the release rates and the total extractable formaldehyde measured by the perforator procedure.



## I. CHARACTERIZATION AND MEASUREMENT

### E. Consumer Products (continued)

71. Young, R. J., R. A. Rinsky, and P. F. Infante. 1978. Benzene in consumer products. Science 199:248. [A, C, F]

Investigator: NIOSH, OSHA

Sponsor: NIOSH; OSHA

Pollutants Measured: benzene

Pollutant Sources: paint stripper

Premises: two-car garage

Geographical Location: NA

Season: summer

Ventilation Rates: approximate wind speed 10 mph

Major Findings: Simulated paint stripping in a garage produced benzene levels ranging from 73 to 225 ppm, well above OSHA proposed standard (1978) for benzene (1 ppm). Other commercial products that contain benzene, and sources of nonoccupational exposure are mentioned.

## I. CHARACTERIZATION AND MEASUREMENT

### F. Combustion Sources

72. Cáceres, T., H. Soto, E. Lissi, and R. Cisternas. 1983. Indoor house pollution: Appliance emissions and indoor ambient concentrations. Atmospheric Environment 17(5):1009-1013. [A, F]

Investigator: Univ. of Santiago, Chile

Sponsor: NA

Pollutants Measured: CO, NO, NO<sub>2</sub>, CH<sub>2</sub>O, SO<sub>2</sub>

Pollutant Sources: unvented gas and kerosene heaters

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Emission rates for CO, NO<sub>2</sub>, CH<sub>2</sub>O and SO<sub>2</sub> from several unvented gas and kerosene heaters frequently employed in domestic heating have been measured. A mass balance model is presented. Predicted steady state concentration and measured values exceed many short-term air quality standards.

73. Coutant, R. W., E. L. Merryman, and A. Levy. 1982. Formation of NO<sub>2</sub> in range-top burners. Environment International 8:185-192. [A, E, F]

Investigator: Battelle Columbus Laboratories

Sponsor: AGA

Pollutants Measured: NO<sub>x</sub>

Pollutant Sources: gas stoves

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Formation of NO and NO<sub>2</sub> on range-top burners and in diffusion flames were characterized by composition and temperature profiles. A limited series of experiments with modified burners indicated emissions could be reduced by (1) improved primary aeration and (2) designs to minimize flame surface. A simplified reaction mechanism was postulated to explain the high NO<sub>2</sub>/NO ratios observed.

## I. CHARACTERIZATION AND MEASUREMENT

### F. Combustion Sources (continued)

74. Girman, J. R., M. G. Apte, G. W. Traynor, J. R. Allen, and C. D. Hollowell. 1982. Pollutant emission rates from indoor combustion appliances and sidestream cigarette smoke. Environment International 8:213-221. [A, F]

Investigator: LBL

Sponsor: DOE; CPSC

Pollutants Measured: CO, CO<sub>2</sub>, NO<sub>x</sub>, CH<sub>2</sub>O, suspended particles

Pollutant Sources: gas stove, kerosene heater, gas space heater, tobacco smoke

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: controlled

Major Findings: Indoor pollutant emission rates from several combustion appliances and concentrations of sidestream tobacco smoke, were measured in a 27 m<sup>3</sup> environmental chamber. Nitrogen dioxide from combustion appliances and particles from sidestream cigarette smoke are the most serious indoor air contaminants based on existing standards.

75. Leaderer, B. P. 1982. Air pollutant emissions from kerosene space heaters. Science 218:1113-1115. [A, F]

Investigator: Yale University, John B. Pierce Foundation Laboratory

Sponsor: PHS

Pollutants Measured: NO<sub>2</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub>

Pollutant Sources: kerosene heaters

Premises: environmental test chamber

Geographical Location: NA

Season: NA

Ventilation Rates: varied

Major Findings: Air pollutant emissions from portable convective and radiant kerosene space heaters were measured in an environmental chamber. Emission factors for nitrogen oxides, sulfur dioxide, carbon monoxide, carbon dioxide, and oxygen depletion are presented. The data suggest that the use of such heaters in residences can result in exposures to air pollutants in excess of ambient air quality standards and in some cases in excess of occupational health standards.

## I. CHARACTERIZATION AND MEASUREMENT

### F. Combustion Sources (continued)

76. McGill, K. C., and D. P. Miller. 1982, Indoor exposure to carbon containing particulates and vapors in homes which use wood for heating. In: Proceedings, Residential Wood and Coal Combustion Conference (March 1982), ed. The Air Pollution Control Association, p. 281-283. [A, B, F]

Investigator: Washburn Univ., Topeka, KS

Sponsor: EPRI

Pollutants Measured: organic particulates and vapors

Pollutant Sources: wood burning appliances

Premises: 8 homes

Geographical Location: NA

Season: heating season

Ventilation Rates: NA

Major Findings: Metal wood stoves show high ratios of semi-volatiles to volatiles; glass-enclosed fireplaces show higher semi-volatiles than open fireplaces. The sampling and analysis method, using catalyst-coated glass filters followed by flame ionization is fast and yields considerable information, although it does not identify particular compounds.

77. Neulicht, R. M., and J. Core. 1982. Impact of residential wood combustion appliances on indoor air quality. In Proceedings, Residential Wood and Coal Combustion Conference (March 1982) ed. The Air Pollution Control Association. p. 240. [A, F]

Investigator: Del Green Associates, Inc., Portland OR

Sponsor: EPA

Pollutants Measured: particulate mass and polynuclear aromatic hydrocarbon (PNA)

Pollutant Sources: wood burning stoves

Premises: 5 houses

Geographical Location: Portland, OR

Season: May, 1980

Ventilation Rates: NA

Major Findings: Four of 5 homes showed no significant increase in particulate mass or PNA when wood burning was going on. One home did have significant increases especially in PNA concentration. The potential for exposure exists and is likely due to improper appliance design, installation or operation.

## I. CHARACTERIZATION AND MEASUREMENT

### F. Combustion Sources (continued)

78. Ritchie, I. M., and L. A. Oatman. 1983. Residential air pollution from kerosene heaters. JAPCA 33(9):879-881. [A, F]

Investigator: Indiana Univ. and Minnesota Dept. of Health

Sponsor: NA

Pollutants Measured: SO<sub>2</sub>, NO, NO<sub>2</sub>, CO, CO<sub>2</sub>

Pollutant Sources: kerosene heaters

Premises: NA

Geographical Location: NA

Season: winter

Ventilation Rates: 0.49-0.81 ach

Major Findings: Kerosene heaters that are oversized for the size of the room generate contaminants in high amounts and possibly unsafe conditions can occur. Although ventilation reduces the pollutant levels, buildup of contaminants may occur at slower rates.

79. Ryan, P. B., J. D. Spengler, and R. Letz. 1983. The effects of kerosene heaters on indoor pollutant concentrations: A monitoring and modeling study. Atmospheric Environment 17(7):1339-1345. [A, F]

Investigator: Harvard School of Public Health

Sponsor: EPA; NIEHS

Pollutants Measured: NO<sub>2</sub>, SO<sub>2</sub>

Pollutant Sources: kerosene heater

Premises: 1 school; 2 houses

Geographical location: Vermont

Season: winter

Ventilation rates: 1-1.5 ach

Major Findings: Measurements of NO<sub>2</sub> levels were made in a school and two residences which used kerosene heaters. A simple, mass balance model was used to relate some of the measurement findings. In one residence in which a discrepancy between tracer gas and blower-door estimates of air exchange rates was found, the modeling suggested that the latter estimate was more likely. Modeling of both NO<sub>2</sub> and SO<sub>2</sub> concentrations suggest the possibility of very high pollutant exposures in poorly-ventilated rooms.



## I. CHARACTERIZATION AND MEASUREMENT

### F. Combustion Sources (continued)

80. Sterling, T. D., and D. Kobayashi. 1981. Use of gas ranges for cooking and heating in urban dwellings. JAPCA 31(2):162-165. [A, F]

Investigator: Simon Fraser and Columbia Universities

Sponsor: CTR

Pollutants Measured: CO

Pollutant Sources: gas stoves

Premises: apartments

Geographical Location: New York, NY

Season: NA

Ventilation Rates: NA

Major Findings: A survey of gas consumption patterns in parts of New York (Manhattan, Bronx, Queens) is presented. Findings show that gas ranges may be used extensively as supplemental heating. Limited CO measurements in selected kitchens show that CO levels build to much higher levels in the well-maintained, subsidized housing than in the nonsubsidized units.

81. Traynor, G. W., D. W. Anthon, and C. D. Hollowell. 1982. Technique for determining pollutant emissions from a gas-fired range. Atmospheric Environment 16(12):2979-2987. [A, F]

Investigator: LBL

Sponsor: DOE

Pollutants Measured: CO, NO<sub>x</sub>, SO<sub>2</sub>, CH<sub>2</sub>O, respirable particles

Pollutant Sources: gas stove

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: controlled

Major Findings: Chamber measurements of pollutant emissions from a gas-fired range have shown that carbon monoxide, nitric oxide, nitrogen dioxide, sulfur dioxide formaldehyde and respirable particles were all emitted during the combustion process. Carbon was found to be the dominant element of the respirable particles emitted. A mathematical indoor air quality model was applied to the laboratory studies to calculate pollutant emission rates per caloric value of fuel consumed.

## I. CHARACTERIZATION AND MEASUREMENT

### F. Combustion Sources (continued)

82. Traynor, G. W., M. G. Apte, J. F. Dillworth, C. D. Hollowell, and E. M. Sterling. 1982. The effects of ventilation on residential air pollution due to emissions from a gas-fired range. Environment International 8:447-452. [A, E, F]

Investigator: LBL  
Sponsor: DOE  
Pollutants Measured: CO, NO<sub>x</sub>  
Pollutant Sources: gas stove  
Premises: NA  
Geographical Location: NA  
Season: NA  
Ventilation Rates: controlled

Major Findings: A mass balance model is used to estimate indoor concentrations of pollutants from a gas stove. In conjunction with an experimental research house, the effects of infiltration, whole house ventilation, and local exhaust are studied. The results show that a range hood is the most effective means of removing pollutants emitted from a gas-fired range.

83. Traynor, G. W. et al. 1982. Indoor air pollution from portable kerosene-fired space heaters, wood-burning stoves, and wood-burning furnaces. In Proceedings, Residential Wood and Coal Combustion Conference (March 1982), ed. The Air Pollution Control Association, p. 253-263. [A, E, F]

Investigator: LBL  
Sponsor: APCA  
Pollutants Measured: CO, CO<sub>2</sub>, NO<sub>x</sub>, formaldehyde  
Pollutant Sources: kerosene heaters  
Premises: experimental test chamber  
Geographical Location: Berkeley, CA  
Season: NA  
Ventilation Rates: 0.08 to 0.4 ach

Major Findings: In both the environmental chamber and in houses where the kerosene heater is operated for more than one hour, the OSHA CO<sub>2</sub> standard and California NO<sub>2</sub> standards were exceeded. Wood-burning stoves and furnaces vary greatly in contribution to indoor air quality. They need to be studied to develop ways of reducing their contribution to indoor air pollutant levels.

## I. CHARACTERIZATION AND MEASUREMENT

### F. Combustion Sources (continued)

84. Traynor, G. W., M. G. Apte, J. F. Dillworth, C. D. Hollowell, and E. M. Sterling. 1982. The effects of ventilation on residential air pollution due to emissions from a gas-fired range. Environment International 8:447-452. [A, E, F]

Investigator: LBL

Sponsor: DOE, Office of Health & Environmental Research

Pollutants Measured: CO, CO<sub>2</sub>, NO<sub>x</sub>

Pollutant Sources: gas-fired range

Premises: house

Geographical Location: Berkeley, CA

Season: NA

Ventilation Rates: 0.7-1.6 ach

Major Findings: A single-equation model is shown to adequately predict average whole-house pollutant concentrations. Spot ventilation and range hoods were more effective in removing gas stove pollutants than was general room ventilation.

85. Yamanaka, S., H. Hirose, and S. Takada. 1979. Nitrogen oxide emissions from domestic kerosene-fired and gas-fired appliances. Atmospheric Environment 13:407-412. [A, F]

Investigator: Kyoto City Institute of Public Health

Sponsor: Environmental Agency of Japan

Pollutants Measured: NO<sub>x</sub>

Pollutant Sources: Gas appliances

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Emission rates for NO<sub>x</sub> from several gas appliances were measured. Among the appliances tested were a kerosene heater, gas stove, gas furnace, and gas water heater. A specially designed model hood collected emissions from the various appliances; samples of this combustion gas were used to estimate emission rates.

## I. CHARACTERIZATION AND MEASUREMENT

### G. Odor

86. Berg-Munch, B., and P. O. Fanger. 1982. The influence of air temperature on the perception of body odor. Environment International 8:333-335.  
[A, F]

Investigator: Univ. of Denmark

Sponsor: NA

Pollutants Measured: odor

Pollutant Sources: humans

Premises: auditorium

Geographical Location: Denmark

Season: NA

Ventilation Rates: 1.3 ach

Major Findings: The intensity of human odor in an auditorium was judged by an odor panel in an adjacent space. One half of the sampled air flow was heated, and the other half was unheated. At air temperatures 23-32° C, no significant influence of temperature on perceived intensity of body odor was found.

87. Berglund, B., U. Berglund, T. Lindvall, and H. Nicander-Bredberg. 1982. Olfactory and chemical characterization of indoor air: Towards a psychophysical model for air quality. Environment International 8:327-332.  
[A, F]

Investigator: Univ. of Stockholm, Sweden

Sponsor: Swedish Council for Building Research

Pollutants Measured: Odor

Pollutant Sources: NA

Premises: office buildings, school

Geographical Location: Sweden

Season: NA

Ventilation Rates: NA

Major Findings: The relationship between odor strength of total air samples and the odor strengths of the constituents was investigated in three field experiments in an office building and a new preschool. A psychological model was found that predicts overall odor strength of an air sample from the number of FID-detected components most frequently reported to have a strong odor.

II. CONTROL METHODS  
A. Air-Purifying Methods

88. Hinds, W. C., S. N. Rudnick, E. F. Maher, and M. W. First. 1983. Control of indoor radon decay products by air treatment devices. JAPCA. 33(2): 134-136. [A, F]

Investigator: Harvard School of Public Health

Sponsor: EPA

Pollutants Measured: radon gas

Pollutant Sources: bubbler

Premises: laboratory test chamber

Geographical Location: NA

Season: NA

Ventilation Rates: 0.2-0.8 ach

Major Findings: The efficiency of household air cleaning devices as a means to control radon decay products in existing buildings was determined. Reductions observed at air filtration rates of 0.52 air changes per hour ranged from 50 to 89 percent. Although the electrostatic precipitator produced the greatest reductions, the low cost and simplicity of air circulating fans appear to make them most suitable for residences.

89. Nazaroff, W. W., M. L. Boegel, C. D. Hollowell, and G. D. Roseme. 1981. The use of mechanical ventilation with heat recovery for controlling radon and radon-daughter concentrations in houses. Atmospheric Environment 15:263-270. [A, F]

Investigator: LBL

Sponsor: DOE

Pollutants Measured: radon and radon daughters

Pollutant Sources: NA

Premises: residence

Geographical Location: Carroll County, MD

Season: September 1979

Ventilation Rates: 0.07-0.8 ach

Major Findings: The installation of a mechanical ventilation system with heat recovery was shown to be effective in reducing indoor concentrations of radon and radon daughters. At ventilation rates of 0.6 air changes per hour and higher, radon and radon daughter levels dropped below the guidelines for indoor concentrations. Comparison with other studies indicates that indoor radon buildup may be a problem in many houses with low infiltration rates.



## II. CONTROL METHODS

### A. Air-Purifying Methods (continued)

90. Shair, F. H. 1981. Relating indoor pollutant concentrations of ozone and sulfur dioxide to those outside: Economic reduction of indoor ozone through selective filtration of the make-up air. ASHRAE Transactions 87(Pt.1):116-139. [A, E, F]

Investigator: Cal. Inst. of Technology

Sponsor: Andrew W. Mellon Foundation

Pollutants Measured: O<sub>3</sub> and SO<sub>2</sub>

Pollutant Sources: NA

Premises: 13 separate buildings

Geographical Location: Los Angeles

Season: NA

Ventilation Rates: NA

Major Findings: Twenty-four separate ventilation systems were tested to determine losses of ozone and sulfur dioxide from laboratory-office buildings. The K values (rate constant heterogeneous loss) were found to be 0.04 ft<sup>3</sup>/ft<sup>2</sup>-min and 0.014 ft<sup>3</sup>/ft<sup>2</sup> min for ozone and sulfur dioxide, respectively. It was found that air filtration with activated carbon, when properly operated and used only when ambient ozone rose above 0.08 ppm, maintained indoor levels at less than one-fifth of outside levels.

## II. CONTROL METHODS

### B. Ventilation

91. Berglund, B., I. Johansson, and T. Lindvall. 1982. The influence of ventilation on indoor/outdoor air contaminants in an office building. Environment International 8:395-399. [A, F]

Investigator: Univ. of Stockholm, Sweden  
Sponsor: Swedish Council for Building Research  
Pollutants Measured: CO, CO<sub>2</sub>, NO<sub>x</sub>, organics  
Pollutant Sources: NA  
Premises: office building  
Geographical Location: Sweden  
Season: Autumn, spring  
Ventilation Rates: 16,000 m<sup>3</sup>/hr

Major Findings: An energy-economized office building provides sufficient protection against outdoor pollution provided the location of the air intake system allows for adequate air makeup and mixing. The number and concentration of most air pollutants increased from the air intake along the pathway of the ventilation system. Changes in recirculation of return air affect the concentration of indoor pollutants differently for different compounds. Saving energy by using a ventilation-by-demand system cannot be generally recommended.

92. Caffey, G. E. 1979. Residential air infiltration. ASHRAE Transactions 85(1):41-57. [F]

Investigator: Texas Power & Light  
Sponsor: NA  
Pollutants Measured: NA  
Pollutant Sources: NA  
Premises: 50 homes  
Geographical Location: Dallas, TX  
Season: June  
Ventilation Rates: NA

Major Findings: The "super sucker" was used to effectively isolate and identify areas of infiltration. Twelve major areas of the home that are sources of air leaks are discussed. The impact of inexpensive methods for cutting down infiltration is also discussed.

## II. CONTROL METHODS

### B. Ventilation (continued)

93. Cain, W. S., B. P. Leaderer, R. Isseroff, L. G. Berglund, R. J. Huey, E. D. Lipsitt, and D. Perlman. 1983. Ventilation requirements in buildings-I. Control of occupancy odor and tobacco smoke odor. Atmospheric Environment 17(6):1183-1197. [A, F]

Investigator: Yale University

Sponsor: DOE; NIEHS

Pollutants Measured: CO, butanol, suspended particles

Pollutant Sources: tobacco smoke

Premises: laboratory test chamber

Geographical Location: NA

Season: NA

Ventilation Rates: controlled

Major Findings: In an array of 38 conditions of smoking occupancy, the ventilation deemed necessary so that 75 percent of the persons tested did not perceive the odor of tobacco smoke was 17.5 liter of air per second per person. For both smoking and nonsmoking conditions, a combination of high temperature and humidity exacerbated the odor problem. During smoking, carbon monoxide rarely reached dangerous levels, but suspended particulates often reached levels considered unacceptable outdoors.

94. Cain, W. S., and B. P. Leaderer. 1982. Ventilation requirements in occupied spaces during smoking and nonsmoking occupancy. Environment International 8:505-514. [A, F]

Investigator: Yale University

Sponsor: DOE; NIEHS

Pollutants Measured: CO, suspended particles

Pollutant Sources: tobacco smoke

Premises: laboratory test chamber

Geographical Location: NA

Season: NA

Ventilation Rates: Varied

Major Findings: More than 200 people made judgments of odor intensity and acceptability under various conditions of occupancy (up to 12 nonsmoking occupants; a temperature up to 25.5° C, and up to 16 cigarettes smoked per hour). The results indicate that under nonsmoking conditions and moderate humidity, 7.8 cfm of fresh air per occupant is required to satisfy the occupants while under smoking conditions, at least 5 times as much fresh air is necessary.

## II. CONTROL METHODS

### B. Ventilation (continued)

95. Cole, J. T., T. S. Zawacki, R. H. Elkins, J. W. Zimmer, and R. A. Macriss. 1980. Application of a generalized model of air infiltration to existing homes. ASHRAE Transactions 86(2):765-773. [A, F]

Investigator: Inst. of Gas Technology, Chicago, IL

Sponsor: Gas Research Inst.

Pollutants Measured: NA

Pollutant Sources: NA

Premises: homes

Geographical Location: metropolitan Chicago ; Ottawa, Canada

Season: NA

Ventilation Rates: 0.06-0.68 ach

Major Findings: A generalized model of air infiltration was used to estimate air infiltration characteristics of two test homes. Methodologies are presented for estimating "total crackage", wind shielding by adjacent structures, and structure permeability. Models and actual measurements are compared.

96. Dietz, R. N. and E. A. Cote. 1982. Air infiltration measurements in a home using a convenient perfluorocarbon tracer technique. Environment International 8:419-433. [A, F]

Investigator: Brookhaven National Laboratory

Sponsor: DOE

Pollutants Measured: NA

Pollutant Sources: NA

Premises: home

Geographical Location: Upton, NY

Season: December

Ventilation Rates: 0.2-5.0 ach

Major Findings: The perfluorocarbon technique (PFT) is a precise and reliable methodology for the determination of infiltration rates in homes. Comparison of the PFT tracer method with that of the SF<sub>6</sub> tracer decay approach showed the results of the two methods to be identical within the limits of experimental precision. With the PFT tracer technique, infiltration rates in the range of 0.2 to 5 air changes per hour can be measured over time-averaged periods of 1 day up to several years.

## II. CONTROL METHODS

### B. Ventilation (continued)

97. Hollowell, C. D., J. V. Berk, M. L. Boegel, R. R. Miksch, W. W. Nazaroff, and G. W. Traynor. 1980. Building ventilation and indoor air quality. Studies in Environmental Science 8:387-396. [F]

Investigator: LBL

Sponsor: DOE

Pollutants Measured: CO, NO<sub>2</sub>, CH<sub>2</sub>O, radon

Pollutant Sources: NA

Premises: homes

Geographical Location: Varied

Season: NA

Ventilation Rates: varied

Major Findings: Various indoor air contaminants were measured at energy-efficient research houses and buildings throughout the United States. Findings suggest that further studies are needed to develop criteria for maintaining indoor air quality without compromising energy efficiency.

98. Janssen, J. E., T. J. Hill, J. E. Woods, and E. A. B. Maldonado. 1982. Ventilation for control of indoor air quality: A case study. Environment International 8:487-496. [A, F]

Investigator: Honeywell, Inc. Minneapolis, MN

Sponsor: LBL

Pollutants Measured: CO<sub>2</sub>

Pollutant Sources: NA

Premises: School

Geographical Location: Fridley, MN

Season: Jan-Feb

Ventilation Rates: 5 L of air/sec per occupant

Major Findings: Energy reduction of approximately 20 percent can be achieved by means of a CO<sub>2</sub>-feedback-control ventilation system which is responsive to room occupancy load. The design of the energy-efficient ventilation system must consider the location of both the supply and return terminal units.



## II. CONTROL METHODS

### B. Ventilation (continued)

99. Janssen, J. E., A. N. Pearman, and T. J. Hill. 1980. Calculating infiltration: An examination of handbook models. ASHRAE Transactions 86(2): 751-764. [A, F]

Investigator: Honeywell, Inc., Minneapolis, MN

Sponsor: NA

Pollutants Measured: NA

Pollutant Sources: NA

Premises: test houses

Geographical Location: California, Minnesota

Season: NA

Ventilation Rates: 0.10-0.12 ach

Major Findings: The ASHRAE air exchange method estimates infiltration with sufficient accuracy for sizing of heating and cooling equipment for normal construction. In comparing estimated infiltration due to wind with actual measurements, they found reasonable agreement--though larger homes were underestimated. Temperature differential through fireplace stacks are inconsequential in determining air infiltration.

100. Kalliokoski, P., R. Niemela, J. Salmivaara. 1980. The tracer gas technique--a useful tool for industrial hygiene. Scandinavian Journal of Work & Environmental Health 6:123-130. [A, F]

Investigator: Univ. Kupio, Kuopio, Finland

Sponsor: Univ. of Kuopio

Pollutants Measured: NA

Pollutant Sources: NA

Premises: rotogravure press

Geographical Location: Finland

Season: NA

Ventilation Rates: 16,000 to 47,000 m<sup>3</sup>/h exhaust rate

Major Findings: Carbon dioxide, nitrous oxide, and sulfur hexfluoride were used to elicit ventilation rates and determine spreading routes of dilution air in the work environment. The local flow rates of dilution air and the percentages of makeup air present were the most important information gained in the ventilation studies.

## II. CONTROL METHODS

### B. Ventilation (continued)

101. Lagus, P. L. 1977. Characterization of building infiltration by the tracer-dilution method. Energy 2:461-464. [F]

Investigator: Systems, Science & Software, LaJolla, CA

Sponsor: Systems, Science, & Software

Pollutants Measured: NA

Pollutant Sources: NA

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Air infiltration cannot be reliably calculated but must be measured in a structure. The tracer-dilution method is a useful technique to determine infiltration rates. The technique entails measurement of logarithmic dilution rate of a tracer gas concentration with respect to time.

102. Malmström, T., and A. Ahlgren. 1982. Efficient ventilation in office rooms. Environment International 8:401-408. [A, F]

Investigator: Royal Institute of Technology, Sweden

Sponsor: The Swedish Council for Building Research

Pollutants Measured: NA

Pollutant Sources: NA

Premises: laboratory test chamber

Geographical Location: Stockholm, Sweden

Season: year-round

Ventilation Rates: 2 ach

Major Findings: A two-box model for calculation of tracer gas concentrations in rooms was developed and tested with dilution and tracer gas experiments. The results indicate a tendency toward lower tracer gas concentrations in the "breathing zone" when supply air is brought into a room at a low (near floor) compared to high (near ceiling) room level.

## II. CONTROL METHODS

### B. Ventilation (continued)

103. McNall, P. E., Jr. 1981. Building ventilation measurements, predictions, and standards. Bulletin of the New York Academy of Medicine 57(10):1027-1043. [F]

Investigator: NBS  
Sponsor: NBS  
Pollutants Measured: NA  
Pollutant Sources: NA  
Premises: NA  
Geographical Location: NA  
Season: NA  
Ventilation Rates: NA

Major Findings: A predictive model (mass balance) for indoor air contaminant concentrations in residences was developed. The model was verified for the case where tobacco smoke is produced indoors. The model can be applied to a wide variety of expected indoor contaminants, production rates, and ventilation rates.

104. Narasaki, M., S. Ishido, and Y. Nakane. 1981. Indoor air pollution and ventilation in sound insulating dining-kitchens. Osaka Daigaku. Kogakubu Technology Reports. 31(16):145-152. [A, E, F]

Investigator: Chubu Inst. of Tech., Kasugai, Japan  
Sponsor: NA  
Pollutants Measured: CO, CO<sub>2</sub>  
Pollutant Sources: gas appliances  
Premises: homes (dining-kitchen)  
Geographical Location: Japan, new airfields  
Season: Fall  
Ventilation Rates: 0.3-1.0 ach

Major Findings: Ventilation systems have varied effects on the removal of CO and CO<sub>2</sub> due in part to air temperature differences and physical location of walls, fans, hoods, etc. They found that natural ventilation differed for each season with higher air exchange rates during the winter (windows closed).

## II. CONTROL METHODS

### B. Ventilation (continued)

105. Offerman, F. J., C. D. Hollowell, W. W. Nazaroff, G. D. Roseme, and J. R. Rizzuto. 1982. Low-infiltration housing in Rochester, New York: A study of air-exchange rates and indoor air quality. Environment International 8:435-445. [A, F]

Investigator: LBL

Sponsor: DOE

Pollutants Measured: Rn, CH<sub>2</sub>O, NO<sub>2</sub>, CO, respirable particles

Pollutant Sources: NA

Premises: home

Geographical Location: Rochester, NY

Season: 80-81 heating season

Ventilation Rates: 0.2-1.7 ach

Major Findings: Air exchange rates were relatively low without mechanical ventilation, yet indoor concentrations of radon, formaldehyde, carbon monoxide, and nitrogen dioxide were below existing guidelines in a sample of 58 occupied residences. Although particulate air fractions were higher indoors than outdoors, mechanical ventilation systems were effective in further reducing indoor contaminant concentrations. When contaminant source strengths are low, acceptable air quality can be compatible with low air-exchange rates.

106. Persily, A. 1982. Evaluation of an air-to-air heat exchanger. Environment International 8:453-459. [F]

Investigator: Princeton University

Sponsor: DOE

Pollutants Measured: NA

Pollutant Sources: NA

Premises: test building

Geographical Location: Princeton, NJ

Season: NA

Ventilation Rates: 0.1-4.57 ach

Major Findings: The Lossnay air-to-air heat exchanger recovered approximately 50 percent of the heat contained in the outgoing air flow from the test chamber. The manufacturers' claimed efficiency and the efficiency as measured by doing a heat balance on the device are close to 70 percent.

## II. CONTROL METHODS

### B. Ventilation (continued)

107. Skåret, E., and H. M. Mathisen. 1982. Ventilation efficiency. Environment International 8:473-481. [A, F]

Investigator: Norwegian Inst. of Technology, Norway

Sponsor: Norwegian Institute of Technology

Pollutants Measured: NA

Pollutant Sources: NA

Premises: laboratory test chamber

Geographical Location: NA

Season: NA

Ventilation Rates: 3.0-6.0 ach

Major Findings: Ventilation systems can be designed for higher ventilation efficiency in the zone of occupation compared to system designs based on complete mixing. Expressions for ventilation efficiency are derived using a two-box model and tracer gas experiments. The mathematical model predicts high efficiencies using diffuse air supply directly to the zone of occupation, if the air is not used for heating.

108. Södergren, David. 1982. A CO<sub>2</sub>-controlled ventilation system. Environment International 8:483-486. [A, F]

Investigator: Paul Peterson AB, Stockholm, Sweden

Sponsor: Paul Peterson AB, Stockholm, Sweden

Pollutants Measured: CO<sub>2</sub>, radon

Pollutant Sources: NA

Premises: office building

Geographical Location: Helsinki, Sweden

Season: winter

Ventilation Rates: 2.5 ach

Major Findings: This study showed that a ventilation system designed to maintain a constant carbon dioxide concentration in the indoor air of a building can operate successfully. Carbon dioxide indicators in the exhaust air controlled the ventilation rate. Aerosol concentrations could also be used as a reference when outside air is required for a building's ventilation system. The system can be used in new, as well as existing buildings.



## II. CONTROL METHODS

### B. Ventilation (continued)

109. Turiel, I., C. D. Hollowell, R. R. Miksch, J. V. Rudy, and R. A. Young. 1983. The effects of reduced ventilation on indoor air quality in an office building. Atmospheric Environment 17(1):51-64. [A, F]

Investigator: LBL

Sponsor: DOE

Pollutants Measured: CH<sub>2</sub>O, organics, CO<sub>2</sub>, CO, NO<sub>2</sub>

Pollutant Sources: NA

Premises: office building

Geographical Location: San Francisco, CA

Season: September 1979

Ventilation Rates: 20 to 33 cfm/person

Major Findings: Indoor air quality was monitored at an office building. The parameters measured were outside air flow rates, temperature, relative humidity, odor perception, microbial burden, particulate mass, formaldehyde and other organics, carbon dioxide, carbon monoxide, and nitrogen dioxide. Carbon dioxide concentrations increased as the ventilation rate decreased; odor perceptibility increased slightly at the lowest ventilation rate, and other pollutants generally showed very low concentrations.

110. Weschler, C. J., S. P. Kelty, and J. E. Lingousky. 1983. The effect of building fan operation on indoor-outdoor dust relationships. JAPCA 33(6):624-629. [A, E, F]

Investigator: Bell Laboratories, New Jersey

Sponsor: Bell Labs.

Pollutants Measured: dust

Pollutant Sources: NA

Premises: telephone equipment buildings

Geographical Location: Wichita, KS and Lubbock, TX

Season: fall, winter, spring

Ventilation Rates: 0.21 ach (Wichita) and 0.24 ach (Lubbock)

Major Findings: Indoor dust concentrations increased when building fans are turned off due to loss of constant filtration. Lack of pressurization is not an important factor. An expression, applicable to similar buildings, is derived for the relative dust increase when the building fans are off.

II. CONTROL METHODS  
C. Source Modification

111. Culot, M. V. J., K. J. Schiager, and H. G. Olson. 1976. Prediction of increased gamma fields after application of a radon barrier on concrete surfaces. Health Physics 30:471-478. [A, F]

Investigator: Centro Nuclear de Mexico; Univ. of Pittsburgh

Sponsor: AEC; EPA

Pollutants Measured: Rn

Pollutant Sources: concrete

Premises: varied

Geographical Location: varied

Season: NA

Ventilation Rates: NA

Major Findings: A sizable reduction in the indoor radon progeny exposure level is anticipated from the application of a radon barrier to indoor surfaces of concrete foundations. A comparison of the gamma exposures associated with concentration profiles prior to and after application of a radon barrier resulted in the prediction of sufficiently low fractional increases to justify field testing of the barrier.

112. Rashidi, M., M. S. Nassoudi, and F. Shadman. 1977. Reduction of carbon monoxide from domestic kerosene heaters. Journal Environmental Science and Health A12(3):115-126. [A, F]

Investigator: Univ. of Technology, Tehran, Iran

Sponsor: Univ. of Technology, Tehran, Iran

Pollutants Measured: CO

Pollutant Sources: kerosene heater

Premises: laboratory test chamber

Geographical Location: Tehran, Iran

Season: NA

Ventilation Rates: NA

Major Findings: A device applying the concepts of both of a thermal reactor and catalysis was developed, which upon testing proved very effective in reducing carbon monoxide emissions. In moderate burning capacities of the heater, the carbon monoxide level was reduced by a factor of two due to the use of the device. In a heater equipped with the device and operating at higher burning capacities, the concentration level of carbon monoxide was reduced by a factor of six.

## II. CONTROL METHODS

### D. Miscellaneous

113. Billings, C. E. and S. F. Vanderslice. 1982. Methods for control of indoor air quality. Environment International 8:497-504. [F]

Investigator: John Hopkins University, Exxon Co.

Sponsor: NA

Pollutants Measured: NA

Pollutant Sources: NA

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: This paper reviews the available methods for the control of environmental hazards due to indoor air pollutants. Alternative methods of control, the performance characteristics of ventilation systems and air cleaning devices, and models for predicting indoor air pollutant concentrations are discussed.

114. Sansome, E. B., and M. W. Slein. 1978. Redispersal of indoor surface contamination: A review. Journal of Hazardous Materials 2:347-361. [F]

Investigator: Frederick Cancer Research Center, Frederick, MD

Sponsor: NCI

Pollutants Measured: NA

Pollutant Sources: surface contamination

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: The importance of surface contamination as a potential source of exposure to hazardous materials is discussed. Data from the literature concerning the resuspension of indoor surface contamination are presented. Reported procedures for quantitating surface contamination are compared. It is suggested that surface contamination monitoring may be useful in estimating potential risks from hazardous materials.

## II. CONTROL METHODS

### D. Miscellaneous (continued)

115. Sawyer, R. N., and E. J. Swoszowski, Jr. 1979. Asbestos abatement in schools: Observations and experiences. Annals of the New York Academy of Sciences 330:765-775. [F]

Investigator: Yale University

Sponsor: Yale University

Pollutants Measured: NA

Pollutant Sources: Asbestos construction material

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: This article summarizes the considerations, failures, and recommendations and methods of the asbestos abatement program for schools. Specific information is provided for school administrators, school boards, governmental agencies, and contractors involved with asbestos abatement projects.

### III. HEALTH STUDIES

116. Beck, B. D., and J. D. Brain. 1982. Prediction of the pulmonary toxicity of respirable combustion products from residential wood and coal stoves. In, Proceedings, Residential Wood and Coal Combustion Conference (March, 1982), ed. The Air Pollution Control Association, p. 264-280. [C]

Investigator: Harvard School of Public Health

Sponsor: Northeast States for Coordinated Air Use Management

Pollutants Measured: NA

Pollutant Sources: wood and coal stove

Premises: laboratory

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Respirable particles from combustion of anthracite coal, bituminous coal, and wood were tested for their potential to cause pulmonary toxicity in hamsters. The intensity of response was comparable to highly toxic alpha-quartz dust and in some cases was even greater. Coal dust showed the greatest response due only in part to its acidity, while wood combustion products showed a response between that of coal and nontoxic dusts.

117. Binder, R. E., C. A. Mitchell, H. R. Hosein, and A. Bouhuys. 1976. Importance of the indoor environment in air pollution exposure. Archives of Environmental Health 31:277-279. [A, C, D, F]

Investigator: Yale Univ. Lung Research Center

Sponsor: National Heart & Lung Institute

Pollutants Measured: respirable particulate, SO<sub>2</sub>, NO<sub>2</sub>

Pollutant Sources: cigarette smoke

Premises: home, school, playground

Geographical Location: Ansonia, CT

Season: April-June

Ventilation Rates: NA

Major Findings: Personal samplers were affixed to children for 24-hour periods. Particulate exposures were significantly higher for children exposed to cigarette smoke. Individual exposure appears to be determined by indoor rather than outdoor pollutants.



III. HEALTH STUDIES  
(continued)

118. Fleischer, R. L. 1982. Lung cancer and phosphates. Environment International 8:381-385. [C, D]

Investigator: General Electric Research & Development Center, NY

Sponsor: NA

Pollutants Measured: radon

Pollutant Sources: phosphate mines, deposits or processing plants

Premises: NA

Geographical Location: various

Season: NA

Ventilation Rates: NA

Major Findings: A significant correlation was found between counties with high lung cancer rates and counties with phosphate deposits, mines, or processing. Unworked phosphate deposits are apparently not hazardous, but phosphate processing plants are of concern. Problems appear to be more widespread than occupational exposure.

119. Gross, P., J. Tuma, and R. T. P. de Treville. 1971. Lungs of workers exposed to fiber glass: A study of their pathologic changes and their dust content. Archives of Environmental Health 23:67-76. [C]

Investigator: Univ. of Pittsburgh; Industrial Health Foundation, Inc.

Sponsor: NA

Pollutants Measured: fiber glass dust

Pollutant Sources: occupational exposure

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: This study examined the lungs of 20 deceased fiberglass workers, known to have had long-term exposure to fiberglass dust. Lungs of workers were compared to a control group (urban dwellers, presumably without occupational exposure) and no significant differences were found between the two groups--in terms of lung damage, amount of dust, and total number of fibers per lung.

III. HEALTH STUDIES  
(continued)

120. Gupta, K. C., A. G. Ulsamer, and P. W. Preuss. 1982. Formaldehyde in indoor air: Sources and toxicity. Environment International 8:349-358. [C, F]

Investigator: CPSC  
Sponsor: NA  
Pollutants Measured: formaldehyde  
Pollutant Sources: various  
Premises: NA  
Geographical Location: NA  
Season: NA  
Ventilation Rates: NA

Major Findings: This article reviews the research on the health effects of formaldehyde exposure. Included are studies on humans, animals and bacteria. Animal studies have shown that formaldehyde is a carcinogen although human epidemiological studies have not yet confirmed this.

121. Helsing, K. J., G. W. Comstock, M. B. Meyer, and M. L. Tockman. 1982. Respiratory effects of household exposures to tobacco smoke and gas cooking on nonsmokers. Environment International 8:365-370. [C, D]

Investigator: Johns Hopkins University  
Sponsor: NIEHS; National Heart, Lung and Blood Institute  
Pollutants Measured: NA  
Pollutant Sources: tobacco smoking, gas stoves  
Premises: homes  
Geographical Location: Washington County, MD  
Season: NA  
Ventilation Rates: NA

Major Findings: This epidemiological study looked at the records of a nonsmoking white adult population for health effects. Tobacco smoke showed only a slight association with chronic phlegm and impaired ventilatory function. Gas cooking was more strongly associated with chronic cough and impaired respiratory function.

III. HEALTH STUDIES  
(continued)

122. Hill, J. W., W. S. Whitehead, J. D. Cameron, and G. A. Hedgecock. 1973.  
Glass fibers: Absence of pulmonary hazard in production workers. British  
Journal of Industrial Medicine 30:174-179. [C]

Investigator: Pilkington Brothers Limited  
Sponsor: NA  
Pollutants Measured: NA  
Pollutant Sources: industrial fiber glass exposure  
Premises: NA  
Geographical Location: NA  
Season: NA  
Ventilation Rates: NA

Major Findings: Radiographic and pulmonary function tests, as well as respiratory symptom questionnaires were administered to a group of workers exposed to glass fibers. Compared to a control group, there is no evidence of respiratory hazard.

123. Jones, J. R., I. T. Higgins, M. W. Higgins, and J. B. Keller. 1983.  
Effects of cooking fuels on lung function in nonsmoking women. Archives  
of Environmental Health 38(4):219-222. [C]

Investigator: Univ. of Michigan, School of Public Health  
Sponsor: NA  
Pollutants Measured: NA  
Pollutant Sources: gas ranges  
Premises: homes  
Geographical Location: Tecumseh, Michigan  
Season: NA  
Ventilation Rates: NA

Major Findings: The authors looked for a relationship between gas cooking and lung function, and they found no statistically significant connection. Kitchen exhaust fan use was strongly associated with low lung function suggesting that people who use fans are more sensitive to combustion products or pollutant levels indoors.

III. HEALTH STUDIES  
(continued)

124. Kreiss, K., M. G. Gonzalez, K. L. Conright, and A. R. Scheere. 1982. Respiratory irritation due to carpet shampoo: Two outbreaks. Environment International 8:337-341. [C, D]

Investigator: CDC, Atlanta; Colorado Dept. of Health

Sponsor: NA

Pollutants Measured: sodium dodecyl sulfate

Pollutant Sources: carpet shampoo

Premises: office building

Geographical Location: Colorado

Season: NA

Ventilation Rates: NA

Major Findings: Two outbreaks of respiratory irritation due to the use of carpet shampoo are described. A crude dose-response relationship was found for one office building and improper shampooing (underdilution of clearer) was suspected. Sodium dodecyl sulfate was common to the cleaners that caused irritation.

125. Lebowitz, M. D., D. B. Armet, and R. Knudson. 1982. The effect of passive smoking on pulmonary function in children. Environment International 8:371-373. [C, F]

Investigator: Arizona Health Sciences Center, Tucson

Sponsor: National Heart, Lung and Blood Institute

Pollutants Measured: NA

Pollutant Sources: cigarette smoking

Premises: homes

Geographical Location: Tucson, AZ

Season: NA

Ventilation Rates: NA

Major Findings: Pulmonary function was tested in children among 344 nuclear families. No association was found between children's pulmonary function and parental smoking.

### III. HEALTH STUDIES (continued)

126. Levin, L., and P. W. Purdom. 1983. A review of the health effects of energy conserving materials. American Journal of Public Health 73(6): 683-690. [C, D]

Investigator: Environmental Studies Institute, Drexel Univ., Philadelphia  
Sponsor: NA  
Pollutants Measured: NA  
Pollutant Sources: insulating materials  
Premises: NA  
Geographical Location: NA  
Season: NA  
Ventilation Rates: NA

Major Findings: This article reviews health and safety standards, exposure standards, and regulatory actions associated with insulating materials. Asbestos and formaldehyde are the primary concerns due to known health effects and potential levels of exposure.

127. Olsen, J. H. and M. Døssing. 1982. Formaldehyde induced symptoms in day care centers. American Industrial Hygiene Association Journal 43:366-370. [C, F]

Investigator: Univ. of Copenhagen, Denmark  
Sponsor: NA  
Pollutants Measured: formaldehyde  
Pollutant Sources: new building materials  
Premises: day-care centers  
Geographical Location: Copenhagen  
Season: NA  
Ventilation Rates: NA

Major Findings: A health survey of employees in 7 new day-care centers were compared to matched employees in older buildings. The difference in formaldehyde exposure ranged from 0.43 mg/m<sup>3</sup> in the day care workers to 0.08 mg/m<sup>3</sup> in the control institutions. The day care workers showed higher frequencies of mucous membrane irritation, headache, fatigue, menstrual irregularities and use of analgesics.



III. HEALTH STUDIES  
(continued)

128. Schenker, M. B., S. T. Weiss, and B. J. Murawski. 1982. Health effects of residence in homes with urea-formaldehyde insulation: A pilot study. Environment International 8:359-363. [C]

Investigator: Harvard Medical School; Beth Israel Hospital, Boston

Sponsor: NIEHS

Pollutants Measured: formaldehyde

Pollutant Sources: urea-formaldehyde foam insulation

Premises: NA

Geographical Location: Boston, MA

Season: NA

Ventilation Rates: NA

Major Findings: Residents of homes with urea formaldehyde foam insulation showed no skin sensitivity or respiratory function changes, though memory deficiency and depression were found at higher than expected rates. Chronic low-level formaldehyde exposure may cause mental changes, but further testing is necessary.

129. Spengler, J. D., and K. Sexton. 1983. Indoor air pollution: A public health perspective. Science 221(4605):9-17. [C, F]

Investigator: Harvard School of Public Health

Sponsor: NIEHS; EPRI; EPA

Pollutants Measured: NA

Pollutant Sources: known indoor air pollutants

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: This review article considers known indoor air pollutants and their sources in nonoccupational settings. Risk assessment efforts are hampered by insufficient information concerning number of people exposed, pattern and severity of exposure, and the resulting health consequences. Numerous references are made to recent studies. The authors suggest the need for a comprehensive strategy to investigate indoor pollutants.

III. HEALTH STUDIES  
(continued)

130. Stacy, R. W., and J. Green et al. 1983. A survey of effects of gaseous and aerosol pollutants on pulmonary function of normal males. Archives of Environmental Health 38(2):104-115. [C]

Investigator: EPA, Health Effects Research Laboratory

Sponsor: EPA

Pollutants Measured: O<sub>3</sub>, NO<sub>2</sub>, SO<sub>2</sub>, H<sub>2</sub>SO<sub>3</sub>, Al(SO<sub>4</sub>)<sub>2</sub>, (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub>, NH<sub>4</sub>, NO<sub>3</sub>

Pollutant Sources: NA

Premises: laboratory

Geographical Location: Chapel Hill, NC

Season: NA

Ventilation Rates: NA

Major Findings: Controlled testing revealed significant differences in several pulmonary function tests for ozone and ozone plus aerosols. None of the other pollutants singly or in combination showed significant correlation with reduced pulmonary function.

IV. MODELING  
A. General Models

131. Duan, N. 1982. Models for human exposure to air pollution. Environment International 8:305-309. [F]

Investigator: The Rand Corporation, Santa Monica, CA

Sponsor: The Rand Corporation

Pollutants Measured: NA

Pollutant Sources: NA

Premises: NA

Geographical Location: NA

Season: NA

Ventilation Rates: NA

Major Findings: Four models for human exposure to air pollution are compared, and the advantages and disadvantages of each model are discussed. The four model are: (1) a simple micro-environment monitoring model, (2) a replicated microenvironment monitoring model, (3) a integrated personal monitoring model, and (4) a continuous personal monitoring model.

132. Ishizu, Y. 1980. General equation for the estimation of indoor pollution. Environmental Science & Technology 14:1254-1257. [A, F]

Investigator: Japan Tobacco and Salt Public Corporation

Sponsor: NA

Pollutants Measured: NA

Pollutant Sources: tobacco smoke

Premises: experimental room

Geographical Location: NA

Season: NA

Ventilation Rates: 32 m<sup>3</sup>/min outdoor air; 8 m<sup>3</sup>/min recirculated

Major Findings: An experimental test was performed for a general equation that estimates indoor air quality. New mixing factors were developed and confirmed by experimentation. It was found that the equations developed could be extended to more general cases where pollutant generation rates are time dependent.

#### IV. MODELING

##### A. General Models (continued)

133. Lorenz, F. 1982. Calculation of ventilation requirements in the case of intermittent pollution: Application to enclosed parking garages. Environment International 8:515-524. [A, F]

Investigator: Laboratoire de Physique du Batiment, Belgium

Sponsor: NA

Pollutants Measured: NO<sub>2</sub>

Pollutant Sources: 30 buses

Premises: enclosed parking garage

Geographical Location: NA

Season: NA

Ventilation Rates: 5,805 to 40,950 m<sup>3</sup>/h

Major Findings: A mathematical model that calculates the ventilation requirements for an enclosed parking garage was developed and tested. A dynamic evaluation (a garage where all the cars enter and leave at nearly the same time) using three modes of operation was the basis for model development. Using the model, ventilation rates ranging from 5,805 to 40,950 m<sup>3</sup>/h were calculated, compared with the classical solution (using static steady-state assumptions) of 49,050 m<sup>3</sup>/h.

134. Ozkaynak, H., P. B. Ryan, G. A. Allen, and W. A. Turner. 1982. Indoor air quality modeling: Compartmental approach with reactive chemistry. Environment International 8:461-471. [A, F]

Investigator: Harvard University, Energy and Environmental Policy Center

Sponsor: NIEHS; EPRI; EPA; DOE

Pollutants Measured: NO, NO<sub>2</sub>, NO<sub>x</sub>, CO

Pollutant Sources: gas-fired appliances

Premises: homes

Geographical Location: Newton, MA

Season: April, May, October 1981

Ventilation Rates: NA

Major Findings: One- and multicompartmental models to infer and estimate concentration, emission, removal, ventilation, and transfer (mixing) variables in indoor air were developed and tested. A simple reactive chemistry model accounts for most of the essential features of the nitrogen oxide chemistry in the indoor environment. Short-term (less than 15 minutes) air flow and mixing patterns may be important in controlling pollutant concentrations and thus potential exposure in homes with gas stoves.

#### IV. MODELING

##### A. General Models (continued)

135. Shair, F. H. and K. L. Heitner. 1974. Theoretical model for relating indoor pollutant concentrations to those outside. Environmental Science & Technology 8(5):444-451. [A, F]

Investigator: California Institute of Technology, Pasadena, CA

Sponsor: California Institute of Technology

Pollutants Measured: ozone

Pollutant Sources: ambient air

Premises: office and conference room

Geographical Location: California Inst of Technology, campus

Season: Summer 1973

Ventilation Rates: 1,450 to 1,587 cfm

Major Findings: A dynamic model for relating indoor pollutant concentrations to those outside was developed and tested. When the time interval associated with changes in the outdoor concentration is long, compared to that required either to change the air within the building or to remove the pollutant by internal means, the indoor concentration of pollutant can be related to the outdoor concentration by means of a simple expression.



#### IV. MODELING

##### B. Radon

136. Porstendörfer, J., A. Wicke, and A. Schraub. 1978. The influence of exhalation, ventilation and deposition processes upon the concentration of radon, thoron and their decay products in room air. Health Physics 34:465-473. [F]

Investigator: Institut für Biophysik, West Germany  
Sponsor: Federal Republic of Germany  
Pollutants Measured: radon and radon daughters  
Pollutant Sources: Wall exhalation; air infiltration  
Premises: NA  
Geographical Location: NA  
Season: NA  
Ventilation Rates: NA

Major Findings: This report models (1) the influence of radon and thoron exhalation from building walls and (2) the air-exchange of radon and thoron between the outside and indoor air. Based on a literature review and model calculations, it was shown that compared with outdoor concentrations, the indoor concentrations of radon and thoron daughters are smaller; and the indoor radon concentration depends on building surface exhalation and room ventilation.

137. Rogozen, M. B. 1982. Dynamic simulation of radon daughter concentrations in apartments using solar rockbed heat storage. Environment International 8:89-96. [F]

Investigator: Science Applications, Inc., Los Angeles, CA  
Sponsor: SERI  
Pollutants Measured: radon and radon daughters  
Pollutant Sources: rockbed heat storage system  
Premises: home  
Geographical Location: NA  
Season: NA  
Ventilation Rates: NA

Major Findings: A microcomputer model was developed to simulate  $^{222}\text{Rn}$  and daughter concentrations emitted in the living space of a residential structure equipped with solar rockbed heat storage. During the day, when the living space is isolated from the radon source, interior  $^{222}\text{Rn}$  concentrations approach those of the outdoor. At night, a steady-state concentration (0.001 to 0.018 of the working level) is approached about 6 hours after heat discharge begins. Combinations of source strength, infiltration rate, and exterior radon concentration that would lead to excessive exposure were calculated.

IV. MODELING  
C. Formaldehyde

138. Andersen, I., G. R. Lundqvist, and L. Mølhave. 1975. Indoor air pollution due to chipboard used as a construction material. Atmospheric Environment 9:1121-1127. [A, F]

Investigator: University of Aarhus, Denmark

Sponsor: NA

Pollutants Measured: formaldehyde

Pollutant Sources: chipboard used in walls, floors, ceilings

Premises: homes

Geographical Location: Jutland, Denmark

Season: Feb-Sept 1973

Ventilation Rates: 0 to 2.5 ach

Major Findings: Measurements in 25 rooms in 23 Danish dwellings where chipboard was used in walls, floors, and ceilings showed an average formaldehyde air concentration of  $0.62 \text{ mg/m}^3$ . In climate chamber experiments, the equilibrium concentration of formaldehyde from chipboard was found to be directly proportional with temperature and water vapor concentration in the air. A mathematical model for room air concentrations of formaldehyde was developed and tested.

139. Mølhave, L., P. Bisgaard, and S. Dueholm. 1983. A mathematical model of indoor air pollution due to formaldehyde from urea-formaldehyde glued particle boards. Atmospheric Environment 17(10): 2105-2108. [A, F]

Investigator: Aarhus University and the Technology Institute, Denmark

Sponsor: Danish Technical Research Foundation

Pollutants Measured: formaldehyde

Pollutant Sources: glued particle boards

Premises: new home

Geographical Location: Aarhus, Denmark

Season: NA

Ventilation Rates: 0.6-2.3 ach

Major Findings: A mathematical model is presented for emissions of formaldehyde from particle board. The authors found agreement of  $\pm 15$  percent between actual measurements and calculations based on the model. Confounding factors, such as painting and carpeting are not taken into account. The model may be suitable for classifying particle boards according to their emission of formaldehyde.

#### IV. MODELING

##### D. Ozone

140. Mueller, F., L. Loeb, and W. H. Mapes. 1973. Decomposition rates of ozone in living areas. Environmental Science & Technology 7:342-346. [A, F].

Investigator: General Electric, Louisville, KY  
Sponsor: General Electric  
Pollutants Measured: ozone  
Pollutant Sources: controlled ozone generators  
Premises: various  
Geographical Location: Louisville, KY  
Season: NA  
Ventilation Rates: NA

Major Findings: The decomposition rate of ozone was monitored in several metal test facilities, an office, and a residential structure. The decomposition of ozone in the living areas followed first-order kinetics. The rate of ozone decay is dependent on variation in temperature, relative humidity, prior exposure to metal surfaces, and the number of potentially active catalytic surfaces in the room.

141. Sutton, D. J., K. M. Nodolf, and K. K. Makino. 1976. Predicting ozone concentrations in residential structures. ASHRAE Journal 18(9):21-26. [A, F]

Investigator: Honeywell, Inc. Minneapolis, MN  
Sponsor: Honeywell, Inc.  
Pollutants Measured: ozone  
Pollutant Sources: electronic air cleaners  
Premises: homes  
Geographical Location: various  
Season: NA  
Ventilation Rates: NA

Major Findings: A model was developed for predicting ozone concentrations in closed residential structures, both with and without electronic air cleaners. Predicted ozone concentrations are compared to actual field measurements in several geographical areas. Over the normal range of outdoor ozone concentrations, the indoor ozone concentrations of the closed residences were significantly lower than the outdoor ozone concentration.

## V. GENERAL REVIEWS: INDOOR AIR QUALITY

### A. Treatises

142. Benson, F. B., J. B. Henderson, and D. E. Caldwell. 1972. Indoor-Outdoor Air Pollution Relationships: A Literature Review. Research Triangle Park, NC: U.S. Environmental Protection Agency, National Environmental Research Center.

Summary: This was the first major attempt to summarize what was known about indoor-outdoor relationships.  $SO_2$ , CO,  $CO_2$  particulates, and biological pollutants are reviewed. Factors that affect indoor concentrations are discussed. Among the important conclusions is the idea that for nonbiological pollutants, outdoor concentration is the major factor determining indoor concentration.

143. Meyer, B. 1982. Indoor Air Quality. Reading, MA: Addison-Wesley.

Summary: This book provides an interdisciplinary introduction to the subject. Topics covered include a historical perspective on indoor air quality, a discussion of specific indoor air pollutants, methods of monitoring and analysis, health effects, control techniques and regulations. References and a bibliography are included.

144. National Academy of Science. 1981. Indoor Pollutants. Washington, D.C.: National Academy Press.

Summary: This report was prepared at the request of the Environmental Protection Agency, by the Committee on Indoor Pollutants, appointed by the National Research Council. The report represents an enormous undertaking: to review, compile, and appraise knowledge of indoor air pollution. By its scope and sheer volume, the work must be considered as defining the state-of-the-art at the time of its publication.

145. Wadden, R. A., and P. A. Scheff. 1983. Indoor Air Pollution. New York: John Wiley & Sons.

Summary: This book is organized into four parts: characterization, prediction, control, and application. It presents a brief overview of indoor pollutant sources, measurement techniques, and health effects criteria. The use of mathematical models to predict indoor concentration levels receives the most extensive treatment. References are arranged by chapter and are current through 1981.

V. GENERAL REVIEWS: INDOOR AIR QUALITY

A. Treatises  
(continued)

146. Walsh, P. J., C. S. Dudley, and E. D. Copenhaver, eds. 1983. Indoor Air Quality. Boca Raton, FL: CRC Press.

Summary: This volume is an edited work with ten chapters by different authors writing in their area of expertise. The subject areas covered by the book are limited, but each topic is treated fully. The book is divided into four sections: (1) introduction, (2) generic aspects (measurement techniques and health risk assessment), (3) phenomenological aspects (indoor air quality in residences, indoor air quality in energy efficient residences, and building-associated epidemics), and (4) pollutant-specific aspects (formaldehyde, radon, ambient tobacco smoke, and allergens/pathogens).



V. GENERAL REVIEWS: INDOOR AIR QUALITY

B. Bibliographies

147. Geomet, Incorporated. 1979. Indoor-Outdoor Pollution Levels: A Bibliography. Palo Alto, CA. Electric Power Research Institute.

Summary: This report presents an extensive annotated bibliography of publications and research pertaining to indoor air pollution. Citations are arranged alphabetically by principal author and are current through 1978. Each listed paper was reviewed to provide an abstract. Indices by subject and by author are provided.

148. Henderson, J. J., F. B. Benson, and D. E. Caldwell. 1973. Indoor-Outdoor Air Pollution Relationships: Volume II, An Annotated Bibliography. Springfield, VA: National Technical Information Service, U.S. Dept. of Commerce.

Summary: This report presents a bibliography of publications related to indoor-outdoor air pollution. One hundred and seven early (prior to 1973) works are included, arranged alphabetically. Indexing by author, subject, and title is provided.

149. Lepman, S. R., M. L. Boegel, and C. D. Hollowell. 1981. Radon: A Bibliography. Springfield, VA: National Technical Information Service, U.S. Department of Commerce.

Summary: This report presents a bibliography of radon-related research. Citations are arranged alphabetically by principal author; author abstracts are included where available. Entries are current through 1980. No indexing of citations is provided. The bibliography represents citations contained in computerized database (VIAQ).

#### 4.3 Bibliographic Update

##### I. CHARACTERIZATION AND MEASUREMENT

###### A1. Aerosols: Indoor aerosols

1. Aurand, K., M. Drews, and B. Seifert. 1983. A passive sampler for the determination of the heavy metal burden of indoor environments. Environmental Technology Letters 4:433-440.
2. Hayward, S. B., K. Sexton, and L. M. Webber. 1984. Application of automated particle analysis to indoor source apportionment. Proceedings of the Annual Meeting of the Air Pollution Control Association 84-33.8.
3. Janka, K. 1984. Optical particle counter as a wide range, continuous monitor for particle concentration. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. II. Radon, Passive Smoking, Particulates and Housing Epidemiology, pp. 215-220.
4. Mekler, M. 1984. Analysis of low particulate size concentration levels in office environments. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. II. Radon, Passive Smoking, Particulates and Housing Epidemiology., pp. 209-214.
5. Sexton, K., L. M. Webber, S. B. Hayward, R. G. Sextro, and F. J. Offerman. 1984. Characterization of particulate and organic emissions from major indoor sources. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 163-168.
6. Weschler, C., and K. Fong. 1984. Characterization of organic species associated with indoor aerosol particles. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. II. Radon, Passive Smoking, Particulates and Housing Epidemiology, pp. 203-208.

## I. CHARACTERIZATION AND MEASUREMENT

### A2. Aerosols: Tobacco smoke

7. Bergman, H., C. Edling, and O. Axelson. 1984. Indoor radon daughter concentration and passive smoking. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. II. Radon, Passive Smoking, Particulates and Housing Epidemiology, pp. 79-84.
8. Clausen, G. H., P. O. Fanger, W. S. Cain, and B. P. Leaderer. 1984. Stability of tobacco smoke odor in enclosed spaces. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. III. Sensory and Hyperactivity Reaction to Sick Buildings, pp. 437-442.
9. Hoffman, D., K. Brunnemann, J. Adams, and N. Haley. 1984. Indoor air pollution by tobacco smoke; model studies on the uptake by nonsmokers. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. II. Radon, Passive Smoking, Particulates and Housing Epidemiology, pp. 313-318.
10. Hugod, C. 1984. Passive smoking--a source of indoor air pollution. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. II. Radon, Passive Smoking, Particulates and Housing Epidemiology, pp. 319-326.
11. Huynh, C. K., T. Vu Duc, C. Debonneville, and P. Boiteux. 1984. Pollution of interior air by polynuclear hydrocarbon from tobacco smoke. Sozial Praeventivmedizin 29:201-202.
12. Leaderer, B. P., W. S. Cain, R. Isseroff, and L. B. Berglund. 1984. Ventilation requirements in buildings. II. Particulate matter and carbon monoxide from cigarette smoking. Atmospheric Environment 18:99-106.
13. Matsushita, H., and T. Mori. 1984. NO<sub>2</sub> and nitrosamine levels in indoor air and side-stream smoke of cigarette. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. II. Radon, Passive Smoking, Particulates and Housing Epidemiology, pp. 335-340.
14. Offerman, F. J., J. Girman, and R. G. Sextro. 1984. Controlling indoor air pollution from tobacco smoke: models and measurements. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. I. Recent Advances in Health Sciences and Technology, pp. 257-264.
15. Pickert, W., J. Robinson, and N. Collishaw. 1984. Yields of tar, nicotine, and carbon monoxide in the sidestream smoke of 15 brands of Canadian cigarettes. American Journal of Public Health. 74:228-231.

I. CHARACTERIZATION AND MEASUREMENT

A2. Aerosols: Tobacco smoke  
(continued)

16. Repace, J. L., and A. H. Lowrey. 1984. A proposed indoor air quality standard for ambient tobacco smoke. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. V. Buildings, Ventilation and Thermal Climate, pp. 235-240.

## I. CHARACTERIZATION AND MEASUREMENT

A3. Aerosols: Asbestos

A4. Aerosols: Fibrous glass and mineral wool

A5. Aerosols: Viable aerosols

17. Botzenhart, K., K. Altenhoff, and T. Leithold. 1984. Molds in the air of greenhouse homes. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. III. Sensory and Hyperactivity Reaction to Sick Buildings, pp. 277-282.
18. Lebowitz, M. D., G. Corman, M. K. O'Rourke, and C. Holberg. 1984. Indoor-outdoor air pollution; allergen and meteorological monitoring in arid southwest areas. Journal of the Air Pollution Control Association 34:1035-1038.
19. Morey, P., M. Hodgson, W. Sorenson, G. Kullman, W. Rhodes, and G. Visvesvara. 1984. Environmental studies in moldy office buildings: biological agents, sources and preventive measures. Evaluating Office Environmental Problems. American Conferences of Governmental Industrial Hygienists. 10:21-36.
20. Reed, C., and M. Swanson. 1984. Indoor allergens: identification and quantification. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol I. Recent Advances in Health Sciences and Technology, pp. 99-108.



## I. CHARACTERIZATION AND MEASUREMENT

### B1. Indoor-Outdoor Relationships: Fixed site

21. Camuffo, D. 1983. Indoor dynamic climatology: investigation on the interaction between walls and indoor environment. Atmospheric Environment 17:1803-1809.
22. Davies, T. D., B. Ramer, G. Kaspyzok, and A. C. Delany. 1984. Indoor/outdoor ozone concentrations at a contemporary art gallery. Journal of Air Pollution Control Association 34:135-137.
23. DeBortoli, M., H. Knoppel, E. Pecchio, A. Peil, L. Rogora, H. Schauenburg, H. Schlitt, and H. Vissers. 1984. Integrating "real life" measurements of organic pollution in indoor and outdoor air of homes in northern Italy. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 21-26.
24. Liou, P. J., M. Avdenko, R. Harkov, and J. Daisey. 1984. An indoor-outdoor study of inorganic and organic particulate matter - a pilot study. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 27-32.
25. Pellizzari, E. D., C. M. Sparacino, L. S. Sheldon, C. C. Leininger, H. Zelon, T. D. Hartwell, and L. Wallace. 1984. Sampling and analysis for volatile organics in indoor and outdoor air in New Jersey. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 221-226.
26. Pellizzari, E. D., H. S. Zelon, J. T. Bursey, C. C. Leininger, T. D. Hartwell, and J. Breen. 1984. Sampling and analysis design for volatile halocarbons in indoor and outdoor air. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 203-208.
27. Weschler, C. 1984. Indoor-outdoor relationships for nonpolar organic constituents of aerosol particles. Environmental Science and Technology 18:648-652.

## I. CHARACTERIZATION AND MEASUREMENT

### B2. Indoor-Outdoor Relationships: Exposure monitoring

28. Hartwell, T. D., H. S. Zelon, C. C. Leininger, C. A. Clayton, J. H. Crowder, and E. D. Pellizzari. 1984. Comparative statistical analysis for volatile halocarbons in indoor and outdoor air. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 57-62.
29. Hartwell, T. D., R. L. Perritt, H. S. Zelon, R. W. Whitmore, E. D. Pellizzari, and L. Wallace. 1984. Comparison of indoor and outdoor levels for air volatiles in New Jersey. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 81-86.
30. Holland, D. 1983. CO levels in microenvironment types of four U.S. cities. Environment International 9:369-378.
31. Mitchell, R. I., G. R. Smithson, Jr., B. P. Price, and E. F. Harris. 1984. A pilot study to obtain 24-hour air pollutant exposure profiles. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 75-80.
32. Noy, D., E. Lebrete, J. Boleij, and B. Brunekreef. 1984. Integrated NO<sub>2</sub> exposure estimates. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 37-42.
33. Ryan, P. B., J. D. Spengler, and R. Letz. 1984. Estimating personal exposures to NO<sub>2</sub>. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 141-148.
34. Yanagisawa, Y., H. Matsuki, F. Osaka, H. Kasuga, and H. Nishimura. 1984. Annual variation of personal exposure to nitrogen dioxide. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 33-36.

## I. CHARACTERIZATION AND MEASUREMENT

### C1. Gaseous Pollutants: Inorganics

35. Fortmann, R. C., J. E. Borrazzo, and C. I. Davidson. 1984. Characterization of parameters influencing indoor pollutant concentrations. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 259-264.
36. Ludwig, J. F., and S. R. DiNardi. 1984. The continuous analysis of air infiltration in a residual environment. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. V. Buildings, Ventilation and Thermal Climate, pp. 465-470.
37. Miyazaki, T. 1984. Adsorption characteristics of NO<sub>x</sub> by several kinds of interior materials. Proceedings of the 3rd International Conference on Indoor Air Quality and Climate. Vol. IV. Chemical Characterization and Personal Exposure, pp. 103-110.
38. Shaw, C. 1984. The effect of tracer gas and the accuracy of air-change measurements in buildings. ASHRAE Transactions 90:212-224.
39. Yamanaka, S. 1984. Decay rates of nitrogen oxides in a typical Japanese living room. Environmental Science Technology 18:566-570.

## I. CHARACTERIZATION AND MEASUREMENT

### C2. Gaseous Pollutants: Organics

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### C2. Gaseous Pollutants: Organics (continued)

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### F. Combustion Sources (continued)

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B. Radon

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D. Ozone

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## 5.0 ADDITIONAL CITATIONS

Section 5.0 contains a list of citations to significant earlier studies (dated before 1980) and a few recent studies. These have been arranged by subject following the same organization as the Annotated Bibliography. No annotation is provided, but the articles were reviewed and classified according to the primary objective of the research.



## ADDITIONAL CITATIONS

### I. Characterization and Measurement

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I. Characterization and Measurement

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I. Characterization and Measurement

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D. Radon

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D. Radon

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B. Ventilation

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## II. Control

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Hollowell, C. D., and Berk, J. V., July 1979. Impact of Reduced Infiltration and Ventilation on Indoor Air Quality. ASHRAE Journal Vol. 21(7):49-53.

## II. Control

### D. Miscellaneous

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### III. Health Studies

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Yates, M. W. March-April 1967. A Preliminary Study of Carbon Monoxide Gas in the Home. Journal of Environmental Health Vol. 29(5):413-420.

### IV. Modeling

#### A. General Models

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## 6.0 CONTACT SUMMARIES

Telephone contacts were made with 23 organizations considered active in indoor air quality research. The following section documents these contacts and summarizes the information that was obtained. The information includes the name of the investigator, the project sponsor, project title, and a general description and categorization of the research. Separate contact summaries are provided for each project, thus, a particular organization may have several summaries. Much of this information is included in Table 3-1. Cross-referencing from Table 3-1 to Section 6.0 is provided under the column headed "Investigator and Organization;" the reference "C21", for example, indicates contact summary number 21.

C1

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL  
 PHONE: (415) 486-4023  
 PROJECT TITLE: Passive Instrumentation  
 SPONSOR: DOE  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1981-1985  
 DESCRIPTION: Commercially available monitoring devices for NO<sub>2</sub> have been evaluated; passive devices for HCHO, H<sub>2</sub>O, and CO have been developed; future plans include development of a monitoring device for CO<sub>2</sub> and simple means for measurement of airborne particulates.

## CATEGORIZATION OF RESEARCH

|                                                |                                                      |                                                                                              |
|------------------------------------------------|------------------------------------------------------|----------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                                         |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/> | CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input checked="" type="checkbox"/>   |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                  | Radioactivity <input type="checkbox"/>                                                       |
|                                                | Instrument Development <input type="checkbox"/>      | Formaldehyde <input type="checkbox"/>                                                        |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>              | Other organics <input checked="" type="checkbox"/>                                           |
| _____                                          | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                            |
| _____                                          | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                                       |
| _____                                          |                                                      | Respirable particulates/TSP <input type="checkbox"/>                                         |
| _____                                          | 4. <u>Special Facilities</u>                         | Odor <input type="checkbox"/>                                                                |
| _____                                          | Chamber <input type="checkbox"/>                     | Ozone <input type="checkbox"/>                                                               |
| _____                                          | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                                 |
| _____                                          | Other (Specify) <input type="checkbox"/>             | Multi-pollutant <input type="checkbox"/>                                                     |
| _____                                          | Facility with controlled                             | Ventilation rate (tracer) <input type="checkbox"/>                                           |
| _____                                          | T, RH, flow rate for passive                         | Metals <input type="checkbox"/>                                                              |
| _____                                          | monitor testing. <input type="checkbox"/>            | Pesticides <input type="checkbox"/>                                                          |
| _____                                          | _____                                                | PCB's <input type="checkbox"/>                                                               |
| _____                                          | _____                                                | Other (Specify) <input type="checkbox"/>                                                     |



C2

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL  
 PHONE: (415) 489-4023  
 PROJECT TITLE: Building Materials Emissions  
 SPONSOR: DOE  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1978-1981, 1983-Ongoing  
 DESCRIPTION: This is a phased effort designed to examine interior finishes, adhesives, and solvent emissions. Phase I determines the identity of the heavier organics by GC/MS on samples from small chambers. Phase II (planned for FY'84) will use larger chambers to characterize the emission rates as they are influenced by selected environmental variables; Phase III will involve whole building sampling and attempts to relate the results of Phase II with actual building measurements.

## CATEGORIZATION OF RESEARCH

|                                                |                                                            |                                                                                   |
|------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                             | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>       | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input checked="" type="checkbox"/>      | Modeling <input checked="" type="checkbox"/>               | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input checked="" type="checkbox"/>             | Radioactivity <input type="checkbox"/>                                            |
|                                                | Instrument Development <input checked="" type="checkbox"/> | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                    | Other organics <input checked="" type="checkbox"/>                                |
| _____                                          | Risk Assessment <input type="checkbox"/>                   | Asbestos or other fibers <input type="checkbox"/>                                 |
| _____                                          | Control Technology <input type="checkbox"/>                | Tobacco smoke <input type="checkbox"/>                                            |
| _____                                          |                                                            | Respirable particulates/TSP <input type="checkbox"/>                              |
| _____                                          | 4. <u>Special Facilities</u>                               | Odor <input type="checkbox"/>                                                     |
| _____                                          | Chamber <input checked="" type="checkbox"/> *              | Ozone <input type="checkbox"/>                                                    |
| _____                                          | Research House <input type="checkbox"/>                    | Airborne Biological <input type="checkbox"/>                                      |
| _____                                          | Other (Specify) <input type="checkbox"/>                   | Multi-pollutant <input type="checkbox"/>                                          |
| _____                                          | *30 m <sup>3</sup> (stainless) controlled                  | Ventilation rate <input checked="" type="checkbox"/>                              |
| _____                                          | T, RH, ventilation <input type="checkbox"/>                | (tracer) <input type="checkbox"/>                                                 |
| _____                                          | _____                                                      | Metals <input type="checkbox"/>                                                   |
| _____                                          | _____                                                      | Pesticides <input type="checkbox"/>                                               |
| _____                                          | _____                                                      | PCB's <input type="checkbox"/>                                                    |
|                                                |                                                            | Other (Specify) <input type="checkbox"/>                                          |

C3

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL  
 PHONE: (415) 486-4023  
 PROJECT TITLE: Numerical Data Base  
 SPONSOR: DOE/EPRI/GRI  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1984-Ongoing  
 DESCRIPTION: The objective will be to establish, maintain, archive, and evaluate a data base of field studies that examines indoor air quality in the residential setting. Two important goals are providing public access to this data base and evaluating the quality of the data considered.

## CATEGORIZATION OF RESEARCH

|                         |                                    |                                                         |
|-------------------------|------------------------------------|---------------------------------------------------------|
| 1. <u>Study Type</u>    | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                                    |
| Laboratory <u>    </u>  | Characterization <u>    </u>       | CO <u>    </u> CO <sub>2</sub> <u>    </u>              |
| Field <u>    </u>       | Modeling <u>    </u>               | NO <sub>x</sub> <u>    </u> SO <sub>2</sub> <u>    </u> |
|                         | Monitoring <u>    </u>             | Radioactivity <u>    </u>                               |
|                         | Instrument Development <u>    </u> | Formaldehyde <u>    </u>                                |
| 2. <u>Major Sources</u> | Health Effects <u>    </u>         | Other organics <u>    </u>                              |
| <u>    </u>             | Risk Assessment <u>    </u>        | Asbestos or other fibers <u>    </u>                    |
| <u>    </u>             | Control Technology <u>    </u>     | Tobacco smoke <u>    </u>                               |
| <u>    </u>             |                                    | Respirable particulates/TSP <u>    </u>                 |
| <u>    </u>             | 4. <u>Special Facilities</u>       | Odor <u>    </u>                                        |
| <u>    </u>             | Chamber <u>    </u>                | Ozone <u>    </u>                                       |
| <u>    </u>             | Research House <u>    </u>         | Airborne Biological <u>    </u>                         |
| <u>    </u>             | Other (Specify) <u>    </u>        | Multi-pollutant <u>    </u>                             |
| <u>    </u>             | <u>    </u>                        | Ventilation rate (tracer) <u>    </u>                   |
| <u>    </u>             | <u>    </u>                        | Metals <u>    </u>                                      |
| <u>    </u>             | <u>    </u>                        | Pesticides <u>    </u>                                  |
| <u>    </u>             | <u>    </u>                        | PCB's <u>    </u>                                       |
| <u>    </u>             | <u>    </u>                        | Other (Specify) <u>    </u>                             |

C4

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL  
 PHONE: (415) 486-4023  
 PROJECT TITLE: Study of Radon and Progeny  
 SPONSOR: DOE/OHER/Conservation/BPA  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1978-Ongoing  
 DESCRIPTION: Instrument development has focused on Rn progeny; new effects will attempt to characterize the national distribution of Rn sources using existing data; the various modes of Rn entry into structures will be examined; and air movement within a single room will be studied in an attempt to understand Rn and progeny removal rates.

## CATEGORIZATION OF RESEARCH

|                                     |                                                            |                                                                                   |
|-------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. Study Type                       | 3. Area                                                    | 5. Pollutants                                                                     |
| Laboratory <input type="checkbox"/> | Characterization <input checked="" type="checkbox"/>       | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>      | Modeling <input type="checkbox"/>                          | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                     | Monitoring <input type="checkbox"/>                        | Radioactivity <input checked="" type="checkbox"/>                                 |
|                                     | Instrument Development <input checked="" type="checkbox"/> | Formaldehyde <input type="checkbox"/>                                             |
| 2. Major Sources                    | Health Effects <input type="checkbox"/>                    | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>            | Risk Assessment <input type="checkbox"/>                   | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>            | Control Technology <input type="checkbox"/>                | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>            |                                                            | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>            | 4. Special Facilities                                      | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>            | Chamber <input type="checkbox"/>                           | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>            | Research House <input checked="" type="checkbox"/>         | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>            | Other (Specify) <input type="checkbox"/>                   | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>            | *3-room testhouse with                                     | Ventilation rate (tracer) <input checked="" type="checkbox"/>                     |
| <input type="checkbox"/>            | remote experimental                                        | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>            | control <input type="checkbox"/>                           | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>            | <input type="checkbox"/>                                   | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>            | <input type="checkbox"/>                                   | Other (Specify) <input type="checkbox"/>                                          |

C5

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL  
 PHONE: (415) 486-4023  
 PROJECT TITLE: Pollutants Emitted by Combustion Appliances  
 SPONSOR: CPSC/BPA/DOE/OHER  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1976-1985  
 DESCRIPTION: Previously, gas ranges, ovens, kerosene heaters, unvented gas space heaters and wood stove emissions have been studied. This year two studies are planned: a laboratory study of unvented gas space heaters with O<sub>2</sub> depletion sensors; and a field study of wood stove emissions in two unoccupied homes in Oregon.

## CATEGORIZATION OF RESEARCH

|                                                |                                                                              |                                                                                                         |
|------------------------------------------------|------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                                               | 5. <u>Pollutants</u>                                                                                    |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>                         | CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input checked="" type="checkbox"/>              |
| Field <input checked="" type="checkbox"/>      | Modeling <input checked="" type="checkbox"/>                                 | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input checked="" type="checkbox"/> |
|                                                | Monitoring <input checked="" type="checkbox"/>                               | Radioactivity <input type="checkbox"/>                                                                  |
|                                                | Instrument Development <input type="checkbox"/>                              | Formaldehyde <input checked="" type="checkbox"/>                                                        |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                                      | Other organics <input type="checkbox"/>                                                                 |
| _____                                          | Risk Assessment <input type="checkbox"/>                                     | Asbestos or other fibers <input type="checkbox"/>                                                       |
| _____                                          | Control Technology <input type="checkbox"/>                                  | Tobacco smoke <input type="checkbox"/>                                                                  |
| _____                                          |                                                                              | Respirable particulates/TSP <input checked="" type="checkbox"/>                                         |
| _____                                          | 4. <u>Special Facilities</u>                                                 | Odor <input type="checkbox"/>                                                                           |
| _____                                          | Chamber 30 m <sup>3</sup> (gypsum board) <input checked="" type="checkbox"/> | Ozone <input type="checkbox"/>                                                                          |
| _____                                          | Research House <input checked="" type="checkbox"/>                           | Airborne Biological <input type="checkbox"/>                                                            |
| _____                                          | Other (Specify) <input checked="" type="checkbox"/>                          | Multi-pollutant <input type="checkbox"/>                                                                |
| _____                                          | Mobile lab <input type="checkbox"/>                                          | Ventilation rate (tracer) <input checked="" type="checkbox"/>                                           |
| _____                                          | _____                                                                        | Metals <input type="checkbox"/>                                                                         |
| _____                                          | _____                                                                        | Pesticides <input type="checkbox"/>                                                                     |
| _____                                          | _____                                                                        | PCB's <input type="checkbox"/>                                                                          |
| _____                                          | _____                                                                        | Other (Specify) <input type="checkbox"/>                                                                |

C6

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL  
 PHONE: (415) 486-4023  
 PROJECT TITLE: Particulate Behavior and Its Interaction with Rn Progeny  
 SPONSOR:  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1982-1984  
 DESCRIPTION: The goal is to examine the interaction of particulate (generated by cigarette smoke) and Rn progeny and their removal techniques. Several commercially available control devices (i.e. filters, precipitators) were evaluated for removal of Rn and progeny.

## CATEGORIZATION OF RESEARCH

|                                                |                                                              |                                                                                   |
|------------------------------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                               | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>         | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>                 | Modeling <input checked="" type="checkbox"/>                 | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                          | Radioactivity <input checked="" type="checkbox"/>                                 |
|                                                | Instrument Development <input type="checkbox"/>              | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                      | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>                     | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                       | Control Technology <input checked="" type="checkbox"/>       | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>                       |                                                              | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                                 | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                       | Chamber <input type="checkbox"/>                             | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | Research House <input checked="" type="checkbox"/>           | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                       | Other (Specify) <input checked="" type="checkbox"/>          | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                       | Particle characterization equipment <input type="checkbox"/> | Ventilation rate (tracer) <input checked="" type="checkbox"/>                     |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                     | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                     | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                     | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                     | Other (Specify) <input type="checkbox"/>                                          |



C7

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL  
 PHONE: (415) 486-4023  
 PROJECT TITLE: Indoor Air Quality Control Techniques  
 SPONSOR:  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1979-1984  
 DESCRIPTION: The major focus has been air-to-air heat exchangers. The following research areas will be explored this year: exhaust with heat pump recovery, air washing for HCHO removal, contaminant transfer across heat exchanger cores, examination of methods to monitor the efficiency of ventilation systems, and if time permits NO<sub>2</sub> - surface interactions.

## CATEGORIZATION OF RESEARCH

|                                                |                                                        |                                                                                              |
|------------------------------------------------|--------------------------------------------------------|----------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                         | 5. <u>Pollutants</u>                                                                         |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>   | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>                         |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                      | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                    | Radioactivity <input type="checkbox"/>                                                       |
|                                                | Instrument Development <input type="checkbox"/>        | Formaldehyde <input checked="" type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                | Other organics <input type="checkbox"/>                                                      |
| <u>                    </u>                    | Risk Assessment <input type="checkbox"/>               | Asbestos or other fibers <input type="checkbox"/>                                            |
| <u>                    </u>                    | Control Technology <input checked="" type="checkbox"/> | Tobacco smoke <input type="checkbox"/>                                                       |
| <u>                    </u>                    |                                                        | Respirable particulates/TSP <input type="checkbox"/>                                         |
| <u>                    </u>                    | 4. <u>Special Facilities</u>                           | Odor <input type="checkbox"/>                                                                |
| <u>                    </u>                    | Chamber <input type="checkbox"/>                       | Ozone <input type="checkbox"/>                                                               |
| <u>                    </u>                    | Research House <input checked="" type="checkbox"/> *   | Airborne Biological <input type="checkbox"/>                                                 |
| <u>                    </u>                    | Other (Specify) <input type="checkbox"/>               | Multi-pollutant <input type="checkbox"/>                                                     |
| <u>                    </u>                    | *Test facility to evaluate                             | Ventilation rate <input checked="" type="checkbox"/>                                         |
| <u>                    </u>                    | heat exchangers controlled                             | (tracer)                                                                                     |
| <u>                    </u>                    | T, RH, ventilation, and                                | Metals <input type="checkbox"/>                                                              |
| <u>                    </u>                    | HCHO injection <input type="checkbox"/>                | Pesticides <input type="checkbox"/>                                                          |
| <u>                    </u>                    |                                                        | PCB's <input type="checkbox"/>                                                               |
|                                                |                                                        | Other (Specify) <input type="checkbox"/>                                                     |

C8

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Grimsrud, LBL  
 PHONE: (415) 486-4023  
 PROJECT TITLE: Field Survey of Residential Buildings in the Pacific Northwest  
 SPONSOR: BPA  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1984-1986  
 DESCRIPTION: 300 existing houses will be examined; 50 will be chosen for a 3-phase study of the implications of various degrees of retrofit (weatherization) on indoor air quality; air quality will be monitored in 40 commercial buildings (schools and office buildings) as well as 100 residences (50 conventionally built and 50 built to BPA specifications).

## CATEGORIZATION OF RESEARCH

|                          |                                      |                                                            |
|--------------------------|--------------------------------------|------------------------------------------------------------|
| 1. <u>Study Type</u>     | 3. <u>Area</u>                       | 5. <u>Pollutants</u>                                       |
| Laboratory <u>      </u> | Characterization <u>      </u>       | CO <u>  ✓  </u> CO <sub>2</sub> <u>      </u>              |
| Field <u>  ✓  </u>       | Modeling <u>      </u>               | NO <sub>x</sub> <u>  ✓  </u> SO <sub>2</sub> <u>      </u> |
|                          | Monitoring <u>      </u>             | Radioactivity <u>      </u> <u>  ✓  </u>                   |
|                          | Instrument Development <u>      </u> | Formaldehyde <u>      </u> <u>  ✓  </u>                    |
| 2. <u>Major Sources</u>  | Health Effects <u>      </u>         | Other organics <u>      </u>                               |
| <u>      </u>            | Risk Assessment <u>      </u>        | Asbestos or other fibers <u>      </u>                     |
| <u>      </u>            | Control Technology <u>      </u>     | Tobacco smoke <u>      </u>                                |
| <u>      </u>            |                                      | Respirable particulates/TSP <u>      </u> <u>  ✓  </u>     |
| <u>      </u>            | 4. <u>Special Facilities</u>         | Odor <u>      </u>                                         |
| <u>      </u>            | Chamber <u>      </u>                | Ozone <u>      </u>                                        |
| <u>      </u>            | Research House <u>      </u>         | Airborne Biological <u>      </u>                          |
| <u>      </u>            | Other (Specify) <u>      </u>        | Multi-pollutant <u>      </u>                              |
| <u>      </u>            | <u>      </u>                        | Ventilation rate (tracer) <u>      </u> <u>  ✓  </u>       |
| <u>      </u>            | <u>      </u>                        | Metals <u>      </u>                                       |
| <u>      </u>            | <u>      </u>                        | Pesticides <u>      </u>                                   |
| <u>      </u>            | <u>      </u>                        | PCB's <u>      </u>                                        |
| <u>      </u>            | <u>      </u>                        | Other (Specify) <u>      </u>                              |

C9

## SUMMARY OF RESEARCH

INVESTIGATOR: T.G. Mathews, ORNL  
 PHONE: (615) 574-6248  
 PROJECT TITLE: Indoor Air Quality Study of Experimental Unoccupied Homes  
 SPONSOR: DOE  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1/84-Ongoing  
 DESCRIPTION: The goal of this study is to examine the influence of energy conservation measures on indoor air quality. Three unoccupied research homes of standard construction will be studied.

## CATEGORIZATION OF RESEARCH

|                                                |                                                        |                                                                                   |
|------------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                         | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>   | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>                 | Modeling <input checked="" type="checkbox"/>           | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input checked="" type="checkbox"/>         | Radioactivity <input checked="" type="checkbox"/>                                 |
|                                                | Instrument Development <input type="checkbox"/>        | Formaldehyde <input checked="" type="checkbox"/>                                  |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>               | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                       | Control Technology <input checked="" type="checkbox"/> | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>                       |                                                        | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                           | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                       | Chamber <input type="checkbox"/>                       | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | Research House <input checked="" type="checkbox"/>     | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                       | Other (Specify) <input type="checkbox"/>               | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | Ventilation rate <input checked="" type="checkbox"/>                              |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | ..(tracer) <input type="checkbox"/>                                               |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | Other (Specify) <input type="checkbox"/>                                          |

C10

## SUMMARY OF RESEARCH

INVESTIGATOR: A. Hawthorne, ORNL  
 PHONE: (615) 574-6246  
 PROJECT TITLE: Measure Radon and Formaldehyde  
 SPONSOR: DOE  
 FUNDING LEVEL: \$90,000  
 EFFECTIVE DATES: 12/83-12/84  
 DESCRIPTION: Radon and HCHO will be monitored in three high instrumented energy conservation homes. Alternative measures will be examined for reducing pollutant levels.

## CATEGORIZATION OF RESEARCH

|                                           |                                                        |                                                                                   |
|-------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                      | 3. <u>Area</u>                                         | 5. <u>Pollutants</u>                                                              |
| Laboratory <input type="checkbox"/>       | Characterization <input checked="" type="checkbox"/>   | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input checked="" type="checkbox"/> | Modeling <input type="checkbox"/>                      | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                           | Monitoring <input checked="" type="checkbox"/>         | Radioactivity <input checked="" type="checkbox"/>                                 |
|                                           | Instrument Development <input type="checkbox"/>        | Formaldehyde <input checked="" type="checkbox"/>                                  |
| 2. <u>Major Sources</u>                   | Health Effects <input type="checkbox"/>                | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                  | Risk Assessment <input type="checkbox"/>               | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                  | Control Technology <input checked="" type="checkbox"/> | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>                  |                                                        | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>                  | 4. <u>Special Facilities</u>                           | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                  | Chamber <input type="checkbox"/>                       | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                  | Research House <input type="checkbox"/>                | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                  | Other (Specify) <input type="checkbox"/>               | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                  | <input type="checkbox"/>                               | Ventilation rate (tracer) <input checked="" type="checkbox"/>                     |
| <input type="checkbox"/>                  | <input type="checkbox"/>                               | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                  | <input type="checkbox"/>                               | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                  | <input type="checkbox"/>                               | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                  | <input type="checkbox"/>                               | Other (Specify) <input type="checkbox"/>                                          |

## SUMMARY OF RESEARCH

INVESTIGATOR: A. Hawthorne, ORNL  
PHONE: (615) 574-6246  
PROJECT TITLE: Volatile Organics in Homes  
SPONSOR: CPSC  
FUNDING LEVEL: \$100,000  
EFFECTIVE DATES: 10/82-6/84  
DESCRIPTION: The goal is to identify sources of volatile organics from consumer products. Detailed measurements will be performed in approximately eight (8) homes.

### CATEGORIZATION OF RESEARCH

| 1. Study Type | 3. Area                | 5. Pollutants               |
|---------------|------------------------|-----------------------------|
| Laboratory    | Characterization       | CO                          |
| Field         | Modeling               | CO <sub>2</sub>             |
|               | Monitoring             | NO <sub>x</sub>             |
|               | Instrument Development | SO <sub>2</sub>             |
|               | Health Effects         | Radioactivity               |
|               | Risk Assessment        | Formaldehyde                |
|               | Control Technology     | Other organics              |
|               |                        | Asbestos or other fibers    |
|               |                        | Tobacco smoke               |
|               |                        | Respirable particulates/TSP |
|               |                        | Odor                        |
|               |                        | Ozone                       |
|               |                        | Airborne Biological         |
|               |                        | Multi-pollutant             |
|               |                        | Ventilation rate (tracer)   |
|               |                        | Metals                      |
|               |                        | Pesticides                  |
|               |                        | PCB's                       |
|               |                        | Other (Specify)             |



C12

## SUMMARY OF RESEARCH

INVESTIGATOR: A. Hawthorne, ORNL  
 PHONE: (615) 574-6246  
 PROJECT TITLE: Indoor Air Quality Study of 40 East Tennessee Homes  
 SPONSOR: CPSC/DOE  
 FUNDING LEVEL: \$500,000  
 EFFECTIVE DATES: 1981-1983  
 DESCRIPTION: Indoor air quality was monitored in 40 East Tennessee homes. When unvented combustion devices were used, elevated CO and NO<sub>2</sub> were observed. Elevated particulate levels were associated with certain phases of operation (e.g. stoking, startup). Levels of HCHO and Rn were measured at concentrations above recommended guidelines.

## CATEGORIZATION OF RESEARCH

|                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u><br>Laboratory <input type="checkbox"/><br>Field <input checked="" type="checkbox"/>          | 3. <u>Area</u><br>Characterization <input checked="" type="checkbox"/><br>Modeling <input type="checkbox"/><br>Monitoring <input checked="" type="checkbox"/><br>Instrument Development <input type="checkbox"/><br>Health Effects <input type="checkbox"/><br>Risk Assessment <input type="checkbox"/><br>Control Technology <input type="checkbox"/> | 5. <u>Pollutants</u><br>CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input checked="" type="checkbox"/><br>NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/><br>Radioactivity <input checked="" type="checkbox"/><br>Formaldehyde <input checked="" type="checkbox"/><br>Other organics <input checked="" type="checkbox"/><br>Asbestos or other fibers <input type="checkbox"/><br>Tobacco smoke <input type="checkbox"/><br>Respirable particulates/TSP <input checked="" type="checkbox"/><br>Odor <input type="checkbox"/><br>Ozone <input type="checkbox"/><br>Airborne Biological <input type="checkbox"/><br>Multi-pollutant <input type="checkbox"/><br>Ventilation rate (tracer) <input checked="" type="checkbox"/><br>Metals <input type="checkbox"/><br>Pesticides <input type="checkbox"/><br>PCB's <input type="checkbox"/><br>Other (Specify) <input type="checkbox"/> |
| 2. <u>Major Sources</u><br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____ | 4. <u>Special Facilities</u><br>Chamber <input type="checkbox"/><br>Research House <input type="checkbox"/><br>Other (Specify) <input type="checkbox"/><br>_____<br>_____<br>_____<br>_____<br>_____                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## SUMMARY OF RESEARCH

INVESTIGATOR: T.G. Mathews, ORNL  
PHONE: (615) 574-6248  
PROJECT TITLE: Characterization of HCHO Emission Sources  
SPONSOR: CPSC  
FUNDING LEVEL:  
EFFECTIVE DATES: 1980-Ongoing  
DESCRIPTION: This broad study has focused on four areas: vapor monitoring, chamber methods, flux monitor development, and product characterization. The emission characteristics of pressed wood products (particle board, plywood paneling, and fiber board), ceiling tiles, urea-formaldehyde foam, and fiberglass have been studied. A field component of this study is planned for this year to relate source strengths and observed concentrations in a field setting.

### CATEGORIZATION OF RESEARCH

|    |                             |    |                                                   |    |                                                    |
|----|-----------------------------|----|---------------------------------------------------|----|----------------------------------------------------|
| 1. | <u>Study Type</u>           | 3. | <u>Area</u>                                       | 5. | <u>Pollutants</u>                                  |
|    | Laboratory    ✓             |    | Characterization                  ✓               |    | CO                      CO <sub>2</sub>            |
|    | Field             ✓         |    | Modeling                                —         |    | NO <sub>x</sub> SO <sub>2</sub>                    |
|    |                             |    | Monitoring                              ✓         |    | Radioactivity                              —       |
|    |                             |    | Instrument Development            ✓               |    | Formaldehyde                              ✓        |
| 2. | <u>Major Sources</u>        |    | Health Effects                              —     |    | Other organics                              —      |
|    | <u>Pressedwood products</u> |    | Risk Assessment                              —    |    | Asbestos or other fibers                      —    |
|    | _____                       |    | Control Technology                              — |    | Tobacco smoke                              —       |
|    | _____                       |    |                                                   |    | Respirable particulates/TSP                      — |
|    | _____                       | 4. | <u>Special Facilities</u>                         |    | Odor                              —                |
|    | _____                       |    | Chamber                                      ✓*   |    | Ozone                              —               |
|    | _____                       |    | Research House                              ✓**   |    | Airborne Biological                              — |
|    | _____                       |    | Other (Specify)                              —    |    | Multi-pollutant                              —     |
|    | _____                       |    | <u>*3-200L (Teflon-linked)</u>                    |    | Ventilation rate ..(tracer)                      — |
|    | _____                       |    | <u>**3 houses</u>                                 |    | Metals                              —              |
|    | _____                       |    | _____                                             |    | Pesticides                              —          |
|    | _____                       |    | _____                                             |    | PCB's                              —               |
|    | _____                       |    | _____                                             |    | Other (Specify)                              —     |

C14

## SUMMARY OF RESEARCH

INVESTIGATOR: A. Hawthorne, ORNL  
 PHONE: (615) 574-6246  
 PROJECT TITLE: Data Analysis of 40 Home Indoor Air Quality Study  
 SPONSOR: TVA/EPRI  
 FUNDING LEVEL: \$70,000  
 EFFECTIVE DATES: 1/84-1/85  
 DESCRIPTION: Evaluate the existing data from the 40 Home study. The study will focus on issues of relevance to TVA's energy conservation program. Additional data will be collected on Rn concentrations; energy use regarding conservation measures employed at the study homes will be evaluated.

## CATEGORIZATION OF RESEARCH

|                                           |                                                 |                                                                                   |
|-------------------------------------------|-------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                      | 3. <u>Area</u>                                  | 5. <u>Pollutants</u>                                                              |
| Laboratory <input type="checkbox"/>       | Characterization <input type="checkbox"/>       | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input checked="" type="checkbox"/> | Modeling <input type="checkbox"/>               | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                           | Monitoring <input checked="" type="checkbox"/>  | Radioactivity <input checked="" type="checkbox"/>                                 |
|                                           | Instrument Development <input type="checkbox"/> | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                   | Health Effects <input type="checkbox"/>         | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                  | Risk Assessment <input type="checkbox"/>        | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                  | Control Technology <input type="checkbox"/>     | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>                  |                                                 | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>                  | 4. <u>Special Facilities</u>                    | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                  | Chamber <input type="checkbox"/>                | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                  | Research House <input type="checkbox"/>         | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                  | Other (Specify) <input type="checkbox"/>        | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                  | <input type="checkbox"/>                        | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <input type="checkbox"/>                  | <input type="checkbox"/>                        | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                  | <input type="checkbox"/>                        | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                  | <input type="checkbox"/>                        | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                  | <input type="checkbox"/>                        | Other (Specify) <input type="checkbox"/>                                          |

C15

## SUMMARY OF RESEARCH

INVESTIGATOR: E. Knutson, DOE  
 PHONE: (212) 620-3652  
 PROJECT TITLE: Assessment of Radioactive and Chemically Active Air Contaminants  
 SPONSOR: DOE  
 FUNDING LEVEL: \$1.5 million/year  
 EFFECTIVE DATES:  
 DESCRIPTION: This work focuses on Rn and progeny. Samplers and analyses are provided to state agencies in the Northeast to support characterization studies. Approximately 150-200 homes are involved. A calibration facility for measurement of Rn and Rn progeny is maintained. Efforts are also underway to upgrade, develop, and evaluate measurement methods for these materials.

## CATEGORIZATION OF RESEARCH

|                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u><br>Laboratory <input checked="" type="checkbox"/><br>Field <input checked="" type="checkbox"/> | 3. <u>Area</u><br>Characterization <input checked="" type="checkbox"/><br>Modeling <input type="checkbox"/><br>Monitoring <input checked="" type="checkbox"/><br>Instrument Development <input checked="" type="checkbox"/><br>Health Effects <input type="checkbox"/><br>Risk Assessment <input type="checkbox"/><br>Control Technology <input type="checkbox"/> | 5. <u>Pollutants</u><br>CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/><br>NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/><br>Radioactivity <input checked="" type="checkbox"/><br>Formaldehyde <input type="checkbox"/><br>Other organics <input type="checkbox"/><br>Asbestos or other fibers <input type="checkbox"/><br>Tobacco smoke <input type="checkbox"/><br>Respirable particulates/TSP <input type="checkbox"/><br>Odor <input type="checkbox"/><br>Ozone <input type="checkbox"/><br>Airborne Biological <input type="checkbox"/><br>Multi-pollutant <input type="checkbox"/><br>Ventilation rate (tracer) <input type="checkbox"/><br>Metals <input type="checkbox"/><br>Pesticides <input type="checkbox"/><br>PCB's <input type="checkbox"/><br>Other (Specify) <input type="checkbox"/> |
| 2. <u>Major Sources</u><br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____   | 4. <u>Special Facilities</u><br>Chamber <input checked="" type="checkbox"/><br>Research House <input type="checkbox"/><br>Other (Specify) <input checked="" type="checkbox"/><br>Special equipment for Rn<br>*20m <sup>3</sup> T & RH control <input type="checkbox"/><br>_____<br>_____<br>_____<br>_____                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

C16

## SUMMARY OF RESEARCH

INVESTIGATOR: J. Rundo, Argonne  
 PHONE: (312) 972-4156  
 PROJECT TITLE: Assessment of Natural Rn and Progeny in Single Family Houses  
 SPONSOR: DOE  
 FUNDING LEVEL: \$1 million per year  
 EFFECTIVE DATES: 1978-Ongoing  
 DESCRIPTION: Argonne has examined a few houses to quantify equilibrium between Rn and progeny. They currently have data on approximately 100 houses and are working to expand the base to 1000.

Integrating samplers are being placed with a nonsmoking religious sect in Aberdeen, SD. Argonne has 25 years of experience in measuring Rn.

## CATEGORIZATION OF RESEARCH

|                                                |                                                      |                                                                                   |
|------------------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/> | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input checked="" type="checkbox"/>      | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input checked="" type="checkbox"/>       | Radioactivity <input checked="" type="checkbox"/>                                 |
|                                                | Instrument Development <input type="checkbox"/>      | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>              | Other organics <input type="checkbox"/>                                           |
| _____                                          | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                 |
| _____                                          | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                            |
| _____                                          |                                                      | Respirable particulates/TSP <input type="checkbox"/>                              |
| _____                                          | 4. <u>Special Facilities</u>                         | Odor <input type="checkbox"/>                                                     |
| _____                                          | Chamber <input checked="" type="checkbox"/> *        | Ozone <input type="checkbox"/>                                                    |
| _____                                          | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                      |
| _____                                          | Other (Specify) <input type="checkbox"/>             | Multi-pollutant <input type="checkbox"/>                                          |
| _____                                          | _____                                                | Ventilation rate (tracer) <input type="checkbox"/>                                |
| _____                                          | _____                                                | Metals <input type="checkbox"/>                                                   |
| _____                                          | *6 m <sup>3</sup>                                    | Pesticides <input type="checkbox"/>                                               |
| _____                                          | _____                                                | PCB's <input type="checkbox"/>                                                    |
| _____                                          | _____                                                | Other (Specify) <input type="checkbox"/>                                          |



C17

## SUMMARY OF RESEARCH

INVESTIGATOR: C. Davidson, Carnegie Mellon University  
 PHONE: (412) 573-2951  
 PROJECT TITLE: Energy Performance Monitoring of Inner City Case Study  
 SPONSOR: DOE  
 FUNDING LEVEL: \$100,000  
 EFFECTIVE DATES: 1/83-6/84  
 DESCRIPTION: This study will focus on energy use and air exchange. It will not focus on pollutants, but rather on relating infiltration and meteorological variables. Three (and possibly four) houses will be studied: a research house, a conventional energy efficient house, and an older nonefficient house.

## CATEGORIZATION OF RESEARCH

|                             |                                    |                                                         |
|-----------------------------|------------------------------------|---------------------------------------------------------|
| 1. <u>Study Type</u>        | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                                    |
| Laboratory <u>    </u>      | Characterization <u>  ✓  </u>      | CO <u>    </u> CO <sub>2</sub> <u>    </u>              |
| Field <u>  ✓  </u>          | Modeling <u>  ✓  </u>              | NO <sub>x</sub> <u>    </u> SO <sub>2</sub> <u>    </u> |
|                             | Monitoring <u>  ✓  </u>            | Radioactivity <u>    </u>                               |
|                             | Instrument Development <u>    </u> | Formaldehyde <u>    </u>                                |
| 2. <u>Major Sources</u>     | Health Effects <u>    </u>         | Other organics <u>    </u>                              |
| <u>                    </u> | Risk Assessment <u>    </u>        | Asbestos or other                                       |
| <u>                    </u> | Control Technology <u>    </u>     | fibers <u>    </u>                                      |
| <u>                    </u> |                                    | Tobacco smoke <u>    </u>                               |
| <u>                    </u> |                                    | Respirable partic-                                      |
| <u>                    </u> | 4. <u>Special Facilities</u>       | ulates/TSP <u>    </u>                                  |
| <u>                    </u> | Chamber <u>    </u>                | Odor <u>    </u>                                        |
| <u>                    </u> | Research House <u>  ✓*  </u>       | Ozone <u>    </u>                                       |
| <u>                    </u> | Other (Specify) <u>    </u>        | Airborne Biological <u>    </u>                         |
| <u>                    </u> | Remote computer assisted data      | Multi-pollutant <u>    </u>                             |
| <u>                    </u> | acquisition system <u>    </u>     | Ventilation rate <u>  ✓  </u>                           |
| <u>                    </u> |                                    | ..(tracer) <u>    </u>                                  |
| <u>                    </u> | *Controlled vent. rate <u>    </u> | Metals <u>    </u>                                      |
| <u>                    </u> |                                    | Pesticides <u>    </u>                                  |
| <u>                    </u> |                                    | PCB's <u>    </u>                                       |
| <u>                    </u> |                                    | Other (Specify) <u>  ✓  </u>                            |
|                             |                                    | <u>Meteorological variances</u>                         |

C18

## SUMMARY OF RESEARCH

INVESTIGATOR: C. Davidson, Carnegie Mellon University  
 PHONE: (412) 578-2951  
 PROJECT TITLE: Influence of Building Design and Other Factors on IAQ  
 SPONSOR: NSF  
 FUNDING LEVEL: \$200,000  
 EFFECTIVE DATES: 1/83-6/84  
 DESCRIPTION: Examine the influence of energy conservation measures on indoor air quality and develop predictive models to enhance understanding of source-sink relationships. The study involves onsite measurement of emissions from gas-fired stoves, furnaces, and water heaters.

## CATEGORIZATION OF RESEARCH

|                           |                                    |                                                   |
|---------------------------|------------------------------------|---------------------------------------------------|
| 1. <u>Study Type</u>      | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                              |
| Laboratory <u>    </u>    | Characterization <u>✓</u>          | CO <u>✓</u> CO <sub>2</sub> <u>    </u>           |
| Field <u>✓</u>            | Modeling <u>✓</u>                  | NO <sub>x</sub> <u>✓</u> SO <sub>2</sub> <u>✓</u> |
|                           | Monitoring <u>✓</u>                | Radioactivity <u>✓</u>                            |
|                           | Instrument Development <u>    </u> | Formaldehyde <u>✓</u>                             |
| 2. <u>Major Sources</u>   | Health Effects <u>    </u>         | Other organics <u>    </u>                        |
| Stoves <u>    </u>        | Risk Assessment <u>    </u>        | Asbestos or other fibers <u>    </u>              |
| Furnaces <u>    </u>      | Control Technology <u>✓</u>        | Tobacco smoke <u>    </u>                         |
| Water heaters <u>    </u> |                                    | Respirable particulates/TSP <u>✓</u>              |
| <u>    </u>               | 4. <u>Special Facilities</u>       | Odor <u>    </u>                                  |
| <u>    </u>               | Chamber <u>    </u>                | Ozone <u>✓</u>                                    |
| <u>    </u>               | Research House <u>    </u>         | Airborne Biological <u>    </u>                   |
| <u>    </u>               | Other (Specify) <u>    </u>        | Multi-pollutant <u>    </u>                       |
| <u>    </u>               | <u>    </u>                        | Ventilation rate (tracer) <u>✓</u>                |
| <u>    </u>               | <u>    </u>                        | Metals <u>    </u>                                |
| <u>    </u>               | <u>    </u>                        | Pesticides <u>    </u>                            |
| <u>    </u>               | <u>    </u>                        | PCB's <u>    </u>                                 |
| <u>    </u>               | <u>    </u>                        | Other (Specify) <u>✓</u>                          |
|                           |                                    | <u>Sulfate</u>                                    |
|                           |                                    | Pb                                                |

C19

## SUMMARY OF RESEARCH

INVESTIGATOR: Frank Black, EPA/ESRL  
 PHONE: (919) 541-3037  
 PROJECT TITLE: Automotive Emission Test Facility  
 SPONSOR:  
 FUNDING LEVEL:  
 EFFECTIVE DATES: Ongoing  
 DESCRIPTION: Refrigerated chamber for atmospheric conditioning of vehicles.

## CATEGORIZATION OF RESEARCH

|                                     |                                                 |                                                                                              |
|-------------------------------------|-------------------------------------------------|----------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                | 3. <u>Area</u>                                  | 5. <u>Pollutants</u>                                                                         |
| Laboratory <input type="checkbox"/> | Characterization <input type="checkbox"/>       | CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input checked="" type="checkbox"/>   |
| Field <input type="checkbox"/>      | Modeling <input type="checkbox"/>               | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                     | Monitoring <input type="checkbox"/>             | Radioactivity <input type="checkbox"/>                                                       |
|                                     | Instrument Development <input type="checkbox"/> | Formaldehyde <input checked="" type="checkbox"/>                                             |
| 2. <u>Major Sources</u>             | Health Effects <input type="checkbox"/>         | Other organics <input type="checkbox"/>                                                      |
| <input type="checkbox"/>            | Risk Assessment <input type="checkbox"/>        | Asbestos or other fibers <input type="checkbox"/>                                            |
| <input type="checkbox"/>            | Control Technology <input type="checkbox"/>     | Tobacco smoke <input type="checkbox"/>                                                       |
| <input type="checkbox"/>            |                                                 | Respirable particulates/TSP <input checked="" type="checkbox"/>                              |
| <input type="checkbox"/>            | 4. <u>Special Facilities</u>                    | Odor <input type="checkbox"/>                                                                |
| <input type="checkbox"/>            | Chamber <input checked="" type="checkbox"/>     | Ozone <input type="checkbox"/>                                                               |
| <input type="checkbox"/>            | Research House <input type="checkbox"/>         | Airborne Biological <input type="checkbox"/>                                                 |
| <input type="checkbox"/>            | Other (Specify) <input type="checkbox"/>        | Multi-pollutant <input checked="" type="checkbox"/>                                          |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Ventilation rate (tracer) <input type="checkbox"/>                                           |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Metals <input type="checkbox"/>                                                              |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Pesticides <input type="checkbox"/>                                                          |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | PCB's <input type="checkbox"/>                                                               |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Other (Specify) <input checked="" type="checkbox"/>                                          |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Air leakage <input type="checkbox"/>                                                         |

C20

## SUMMARY OF RESEARCH

INVESTIGATOR: Edo Pellizzari, Research Triangle Institute  
 PHONE: (919) 541-6579  
 PROJECT TITLE: Total Exposure and Assessment Methodology  
 SPONSOR: EPA  
 FUNDING LEVEL: \$4,697,000  
 EFFECTIVE DATES: 9/79-9/84  
 DESCRIPTION: The goal is to assess the personal exposure of people to 21 volatile organic compounds. Home measurements will be made in NJ (560), NC (30), ND (20), LA (175), and PA (75). For the overnight sampling period it has been shown that the indoor/outdoor concentration ratios are consistently above unity. A breath sampler, as well as personal monitors for pesticides and PCB's were developed in this study.

## CATEGORIZATION OF RESEARCH

|                                     |                                                            |                                                                                   |
|-------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                | 3. <u>Area</u>                                             | 5. <u>Pollutants</u>                                                              |
| Laboratory <input type="checkbox"/> | Characterization <input checked="" type="checkbox"/>       | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>      | Modeling <input type="checkbox"/>                          | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                     | Monitoring <input checked="" type="checkbox"/>             | Radioactivity <input type="checkbox"/>                                            |
|                                     | Instrument Development <input checked="" type="checkbox"/> | Formaldehyde <input checked="" type="checkbox"/>                                  |
| 2. <u>Major Sources</u>             | Health Effects <input type="checkbox"/>                    | Other organics <input checked="" type="checkbox"/>                                |
| <input type="checkbox"/>            | Risk Assessment <input type="checkbox"/>                   | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>            | Control Technology <input type="checkbox"/>                | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>            |                                                            | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>            | 4. <u>Special Facilities</u>                               | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>            | Chamber <input checked="" type="checkbox"/>                | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>            | Research House <input type="checkbox"/>                    | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>            | Other (Specify) <input type="checkbox"/>                   | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>            | <input type="checkbox"/>                                   | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <input type="checkbox"/>            | <input type="checkbox"/>                                   | Metals <input checked="" type="checkbox"/>                                        |
| <input type="checkbox"/>            | <input type="checkbox"/>                                   | Pesticides <input checked="" type="checkbox"/>                                    |
| <input type="checkbox"/>            | <input type="checkbox"/>                                   | PCB's <input checked="" type="checkbox"/>                                         |
| <input type="checkbox"/>            | <input type="checkbox"/>                                   | Other (Specify) <input type="checkbox"/>                                          |

C21

## SUMMARY OF RESEARCH

INVESTIGATOR: Edo Pellizzari, Research Triangle Institute  
 PHONE: (919) 541-6579  
 PROJECT TITLE: Assess Halogenated Organic Compounds in Man and Environment  
 SPONSOR: EPA  
 FUNDING LEVEL: \$1,520,000  
 EFFECTIVE DATES: 11/77-4/83  
 DESCRIPTION: The goal was to assess the personal exposure of people to halogenated organics. Indoor and outdoor concentrations were monitored in approximately 150 homes in Greensboro, N.C., Baton Rouge, LA, and Houston, TX.

## CATEGORIZATION OF RESEARCH

|                          |                                      |                                                             |
|--------------------------|--------------------------------------|-------------------------------------------------------------|
| 1. <u>Study Type</u>     | 3. <u>Area</u>                       | 5. <u>Pollutants</u>                                        |
| Laboratory <u>      </u> | Characterization <u>  ✓  </u>        | CO <u>      </u> CO <sub>2</sub> <u>      </u>              |
| Field <u>  ✓  </u>       | Modeling <u>      </u>               | NO <sub>x</sub> <u>      </u> SO <sub>2</sub> <u>      </u> |
|                          | Monitoring <u>  ✓  </u>              | Radioactivity <u>      </u>                                 |
|                          | Instrument Development <u>      </u> | Formaldehyde <u>      </u>                                  |
| 2. <u>Major Sources</u>  | Health Effects <u>  ✓  </u>          | Other organics <u>      </u>                                |
| <u>      </u>            | Risk Assessment <u>      </u>        | Asbestos or other fibers <u>      </u>                      |
| <u>      </u>            | Control Technology <u>      </u>     | Tobacco smoke <u>      </u>                                 |
| <u>      </u>            |                                      | Respirable particulates/TSP <u>      </u>                   |
| <u>      </u>            | 4. <u>Special Facilities</u>         | Odor <u>      </u>                                          |
| <u>      </u>            | Chamber <u>  ✓  </u>                 | Ozone <u>      </u>                                         |
| <u>      </u>            | Research House <u>      </u>         | Airborne Biological <u>      </u>                           |
| <u>      </u>            | Other (Specify) <u>      </u>        | Multi-pollutant <u>      </u>                               |
| <u>      </u>            | <u>      </u>                        | Ventilation rate (tracer) <u>      </u>                     |
| <u>      </u>            | <u>      </u>                        | Metals <u>      </u>                                        |
| <u>      </u>            | <u>      </u>                        | Pesticides <u>      </u>                                    |
| <u>      </u>            | <u>      </u>                        | PCB's <u>      </u>                                         |
| <u>      </u>            | <u>      </u>                        | Other (Specify) <u>  ✓  </u>                                |
| <u>      </u>            | <u>      </u>                        | <u>Halogenated organics</u>                                 |



## SUMMARY OF RESEARCH

INVESTIGATOR: Edo Pellazzari, Research Triangle Institute  
 PHONE: (919) 541-6579  
 PROJECT TITLE: Total Exposure and Assessment Methodology--Indoor Air Study  
 SPONSOR: EPA  
 FUNDING LEVEL: \$350,000  
 EFFECTIVE DATES: 3/82-9/84  
 DESCRIPTION: Three building types were studied: A home for the elderly, a secondary school, and a new office building. The first building was old and had gas heat and stoves in the 199 apartments. Measurements were made outdoors and at 4 to 6 locations indoors. The second building had electric heat and was subjected to the same sampling program. The third building was subjected to a longitudinal study--before and after occupancy. The buildings were characterized and building materials and sources were identified for subsequent chamber studies.

## CATEGORIZATION OF RESEARCH

|                             |                                    |                                                           |
|-----------------------------|------------------------------------|-----------------------------------------------------------|
| 1. <u>Study Type</u>        | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                                      |
| Laboratory <u>    </u>      | Characterization <u>    </u> ✓     | CO <u>    </u> ✓ CO <sub>2</sub> <u>    </u>              |
| Field <u>    </u> ✓         | Modeling <u>    </u> ✓             | NO <sub>x</sub> <u>    </u> ✓ SO <sub>2</sub> <u>    </u> |
|                             | Monitoring <u>    </u> ✓           | Radioactivity <u>    </u>                                 |
|                             | Instrument Development <u>    </u> | Formaldehyde <u>    </u> ✓                                |
| 2. <u>Major Sources</u>     | Health Effects <u>    </u>         | Other organics <u>    </u>                                |
| <u>                    </u> | Risk Assessment <u>    </u>        | Asbestos or other                                         |
| <u>                    </u> | Control Technology <u>    </u>     | fibers <u>    </u>                                        |
| <u>                    </u> |                                    | Tobacco smoke <u>    </u> ✓                               |
| <u>                    </u> |                                    | Respirable particulates/TSP <u>    </u> ✓                 |
| <u>                    </u> | 4. <u>Special Facilities</u>       | Odor <u>    </u>                                          |
| <u>                    </u> | Chamber <u>    </u> ✓              | Ozone <u>    </u>                                         |
| <u>                    </u> | Research House <u>    </u>         | Airborne Biological <u>    </u>                           |
| <u>                    </u> | Other (Specify) <u>    </u>        | Multi-pollutant <u>    </u> ✓                             |
| <u>                    </u> | <u>                    </u>        | Ventilation rate <u>    </u> ✓                            |
| <u>                    </u> | <u>                    </u>        | (tracer) <u>    </u>                                      |
| <u>                    </u> | <u>                    </u>        | Metals <u>    </u> ✓                                      |
| <u>                    </u> | <u>                    </u>        | Pesticides <u>    </u> ✓                                  |
| <u>                    </u> | <u>                    </u>        | PCB's <u>    </u> ✓                                       |
| <u>                    </u> | <u>                    </u>        | Other (Specify) <u>    </u>                               |

C23

## SUMMARY OF RESEARCH

INVESTIGATOR: Ty Hartwell, Research Triangle Institute  
 PHONE: (919) 541-6453  
 PROJECT TITLE: Study of Personal CO Exposure  
 SPONSOR: EPA  
 FUNDING LEVEL: \$605,000  
 EFFECTIVE DATES: 6/82-11/83  
 DESCRIPTION: The CO exposure of residents of Washington, DC and Denver was studied. The project goals were to develop the study methodology for application to other pollutants and to examine 750 person-days of exposure in each location.

## CATEGORIZATION OF RESEARCH

|                             |                                     |                                                         |
|-----------------------------|-------------------------------------|---------------------------------------------------------|
| 1. <u>Study Type</u>        | 3. <u>Area</u>                      | 5. <u>Pollutants</u>                                    |
| Laboratory <u>    </u>      | Characterization <u>  ✓  </u>       | CO <u>  ✓  </u> CO <sub>2</sub> <u>    </u>             |
| Field <u>  ✓  </u>          | Modeling <u>  ✓  </u>               | NO <sub>x</sub> <u>    </u> SO <sub>2</sub> <u>    </u> |
|                             | Monitoring <u>  ✓  </u>             | Radioactivity <u>    </u>                               |
|                             | Instrument Development <u>  ✓  </u> | Formaldehyde <u>    </u>                                |
| 2. <u>Major Sources</u>     | Health Effects <u>    </u>          | Other organics <u>    </u>                              |
| <u>                    </u> | Risk Assessment <u>    </u>         | Asbestos or other                                       |
| <u>                    </u> | Control Technology <u>    </u>      | fibers <u>    </u>                                      |
| <u>                    </u> |                                     | Tobacco smoke <u>    </u>                               |
| <u>                    </u> |                                     | Respirable partic-                                      |
| <u>                    </u> | 4. <u>Special Facilities</u>        | ulates/TSP <u>    </u>                                  |
| <u>                    </u> | Chamber <u>  ✓  </u>                | Odor <u>    </u>                                        |
| <u>                    </u> | Research House <u>    </u>          | Ozone <u>    </u>                                       |
| <u>                    </u> | Other (Specify) <u>    </u>         | Airborne Biological <u>    </u>                         |
| <u>                    </u> | <u>                    </u>         | Multi-pollutant <u>    </u>                             |
| <u>                    </u> | <u>                    </u>         | Ventilation rate                                        |
| <u>                    </u> | <u>                    </u>         | ..(tracer) <u>    </u>                                  |
| <u>                    </u> | <u>                    </u>         | Metals <u>    </u>                                      |
| <u>                    </u> | <u>                    </u>         | Pesticides <u>    </u>                                  |
| <u>                    </u> | <u>                    </u>         | PCB's <u>    </u>                                       |
|                             |                                     | Other (Specify) <u>    </u>                             |

C24

## SUMMARY OF RESEARCH

INVESTIGATOR: Linda Shelton, Research Triangle Institute  
 PHONE: (919) 541-6603  
 PROJECT TITLE: Monitor In and Around Public Access Buildings  
 SPONSOR: EPA  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 9/83-3/85  
 DESCRIPTION: Monitoring of the chemical composition of air is being performed in and around eight buildings. A broad range of vapor and particulate organic and inorganic compounds will be monitored. Emission rates will be determined using chamber studies. Models will be selected and applied to relate collected data.

## CATEGORIZATION OF RESEARCH

|                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u><br>Laboratory <input checked="" type="checkbox"/><br>Field <input checked="" type="checkbox"/>                                                                                                                                                                              | 3. <u>Area</u><br>Characterization <input checked="" type="checkbox"/><br>Modeling <input checked="" type="checkbox"/><br>Monitoring <input checked="" type="checkbox"/><br>Instrument Development <input type="checkbox"/><br>Health Effects <input type="checkbox"/><br>Risk Assessment <input type="checkbox"/><br>Control Technology <input type="checkbox"/> | 5. <u>Pollutants</u><br>CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/><br>NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/><br>Radioactivity <input checked="" type="checkbox"/><br>Formaldehyde <input checked="" type="checkbox"/><br>Other organics <input checked="" type="checkbox"/><br>Asbestos or other fibers <input checked="" type="checkbox"/><br>Tobacco smoke <input type="checkbox"/><br>Respirable particulates/TSP <input checked="" type="checkbox"/><br>Odor <input type="checkbox"/><br>Ozone <input type="checkbox"/><br>Airborne Biological <input type="checkbox"/><br>Multi-pollutant <input checked="" type="checkbox"/><br>Ventilation rate (tracer) <input checked="" type="checkbox"/><br>Metals <input type="checkbox"/><br>Pesticides <input type="checkbox"/><br>PCB's <input type="checkbox"/><br>Other (Specify) <input type="checkbox"/> |
| 2. <u>Major Sources</u><br><u>adhesive</u><br><u>spray insulation</u><br><u>wall covering</u><br><u>carpet</u><br><u>carpet pad</u><br><u>paints</u><br><u>disinfectants</u><br><u>pesticides</u><br><u>sealants</u><br><u>plastic lenses</u><br><u>lamp ballasts</u><br>_____<br>_____<br>_____ | 4. <u>Special Facilities</u><br>Chamber <input checked="" type="checkbox"/> *<br>Research House <input type="checkbox"/><br>Other (Specify) <input checked="" type="checkbox"/><br>Mobile monitoring laboratory<br>*18 m <sup>3</sup> , 3.6 m <sup>3</sup> , 700L, 40L<br>_____<br>_____<br>_____                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

C25

## SUMMARY OF RESEARCH

INVESTIGATOR: J. Lodge, Research Triangle Institute  
 PHONE: (919) 541-6905  
 PROJECT TITLE: Analysis of Termiticide Air Samples  
 SPONSOR: USAF  
 FUNDING LEVEL: \$375,000  
 EFFECTIVE DATES: 2/80-Ongoing  
 DESCRIPTION: 11,500 samples collected in military housing were analyzed for chlordane, dieldrin, aldrin, and heptachlor. One report entitled "chlordane in Air Force Family Housing: A study of Slad-on-Grade Houses" (USAF OEHL Report 83-129 EH111 DPB) is available. Airborne chlordane levels are unlikely to exceed 5 mg/cubic meter in houses treated prior to construction; post-construction treatment is more likely to result in detectable chlordane in the living space.

## CATEGORIZATION OF RESEARCH

|                                     |                                                 |                                                                                   |
|-------------------------------------|-------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                | 3. <u>Area</u>                                  | 5. <u>Pollutants</u>                                                              |
| Laboratory <input type="checkbox"/> | Characterization <input type="checkbox"/>       | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>      | Modeling <input type="checkbox"/>               | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                     | Monitoring <input checked="" type="checkbox"/>  | Radioactivity <input type="checkbox"/>                                            |
|                                     | Instrument Development <input type="checkbox"/> | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>             | Health Effects <input type="checkbox"/>         | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>            | Risk Assessment <input type="checkbox"/>        | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>            | Control Technology <input type="checkbox"/>     | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>            |                                                 | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>            | 4. <u>Special Facilities</u>                    | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>            | Chamber <input checked="" type="checkbox"/>     | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>            | Research House <input type="checkbox"/>         | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>            | Other (Specify) <input type="checkbox"/>        | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Pesticides <input checked="" type="checkbox"/>                                    |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Other (Specify) <input type="checkbox"/>                                          |

C26

## SUMMARY OF RESEARCH

INVESTIGATOR: M.D. Lebowitz, University of Arizona  
 PHONE: (602) 626-6379  
 PROJECT TITLE: Pollutants, Aeroallergens, and Respiratory Diseases  
 SPONSOR: EPA/NIH  
 FUNDING LEVEL: Approximately \$600,000  
 EFFECTIVE DATES: 1978-1981  
 DESCRIPTION: A health effects study was conducted focusing on exposure to CO, O<sub>3</sub>, TSP, RSP, pollen, bacilli, fungi, algae, and tobacco smoke. Indoor and outdoor monitoring was conducted for 40 homes; 200 homes were considered in 4 geographic clusters. Acute and chronic respiratory symptoms were considered.

## CATEGORIZATION OF RESEARCH

|                          |                                      |                                                             |
|--------------------------|--------------------------------------|-------------------------------------------------------------|
| 1. <u>Study Type</u>     | 3. <u>Area</u>                       | 5. <u>Pollutants</u>                                        |
| Laboratory <u>      </u> | Characterization <u>  ✓  </u>        | CO <u>  ✓  </u> CO <sub>2</sub> <u>      </u>               |
| Field <u>  ✓  </u>       | Modeling <u>      </u>               | NO <sub>x</sub> <u>      </u> SO <sub>2</sub> <u>      </u> |
|                          | Monitoring <u>  ✓  </u>              | Radioactivity <u>      </u>                                 |
|                          | Instrument Development <u>      </u> | Formaldehyde <u>      </u>                                  |
| 2. <u>Major Sources</u>  | Health Effects <u>  ✓  </u>          | Other organics <u>      </u>                                |
| <u>      </u>            | Risk Assessment <u>      </u>        | Asbestos or other fibers <u>      </u>                      |
| <u>      </u>            | Control Technology <u>      </u>     | Tobacco smoke <u>  ✓  </u>                                  |
| <u>      </u>            |                                      | Respirable particulates/TSP <u>  ✓  </u>                    |
| <u>      </u>            | 4. <u>Special Facilities</u>         | Odor <u>      </u>                                          |
| <u>      </u>            | Chamber <u>      </u>                | Ozone <u>  ✓  </u>                                          |
| <u>      </u>            | Research House <u>      </u>         | Airborne Biological <u>  ✓  </u>                            |
| <u>      </u>            | Other (Specify) <u>      </u>        | Multi-pollutant <u>      </u>                               |
| <u>      </u>            | <u>      </u>                        | Ventilation rate (tracer) <u>      </u>                     |
| <u>      </u>            | <u>      </u>                        | Metals <u>      </u>                                        |
| <u>      </u>            | <u>      </u>                        | Pesticides <u>      </u>                                    |
| <u>      </u>            | <u>      </u>                        | PCB's <u>      </u>                                         |
| <u>      </u>            | <u>      </u>                        | Other (Specify) <u>      </u>                               |



C27

## SUMMARY OF RESEARCH

INVESTIGATOR: W.M. Hedley, Monsanto Research  
 PHONE: (513) 268-3411  
 PROJECT TITLE: Industrial Hygiene/Control Technology Assessment of Formaldehyde Production Facilities  
 SPONSOR: NIOSH  
 FUNDING LEVEL: \$630,000  
 EFFECTIVE DATES: 9/80-9/83  
 DESCRIPTION: Initially the study was to be a combination workplace - residence worker-exposure study. The final study did not deal with nonoccupational exposure but instead focused on occupational exposure of workers in the formaldehyde industry. Ten preliminary surveys were performed and four detailed surveys were conducted.

## CATEGORIZATION OF RESEARCH

|                                               |                                      |                                                             |
|-----------------------------------------------|--------------------------------------|-------------------------------------------------------------|
| 1. <u>Study Type</u>                          | 3. <u>Area</u>                       | 5. <u>Pollutants</u>                                        |
| Laboratory <u>      </u>                      | Characterization <u>  ✓  </u>        | CO <u>      </u> CO <sub>2</sub> <u>      </u>              |
| Field <u>  ✓  </u>                            | Modeling <u>      </u>               | NO <sub>x</sub> <u>      </u> SO <sub>2</sub> <u>      </u> |
|                                               | Monitoring <u>  ✓  </u>              | Radioactivity <u>      </u>                                 |
|                                               | Instrument Development <u>      </u> | Formaldehyde <u>  ✓  </u>                                   |
| 2. <u>Major Sources</u>                       | Health Effects <u>      </u>         | Other organics <u>      </u>                                |
| Formaldehyde manu-<br>facturing <u>      </u> | Risk Assessment <u>      </u>        | Asbestos or other<br>fibers <u>      </u>                   |
| <u>      </u>                                 | Control Technology <u>  ✓  </u>      | Tobacco smoke <u>      </u>                                 |
| <u>      </u>                                 |                                      | Respirable partic-<br>ulates/TSP <u>      </u>              |
| <u>      </u>                                 | 4. <u>Special Facilities</u>         | Odor <u>      </u>                                          |
| <u>      </u>                                 | Chamber <u>      </u>                | Ozone <u>      </u>                                         |
| <u>      </u>                                 | Research House <u>      </u>         | Airborne Biological <u>      </u>                           |
| <u>      </u>                                 | Other (Specify) <u>      </u>        | Multi-pollutant <u>      </u>                               |
| <u>      </u>                                 | <u>      </u>                        | Ventilation rate<br>(tracer) <u>      </u>                  |
| <u>      </u>                                 | <u>      </u>                        | Metals <u>      </u>                                        |
| <u>      </u>                                 | <u>      </u>                        | Pesticides <u>      </u>                                    |
| <u>      </u>                                 | <u>      </u>                        | PCB's <u>      </u>                                         |
| <u>      </u>                                 | <u>      </u>                        | Other (Specify) <u>      </u>                               |

C28

## SUMMARY OF RESEARCH

INVESTIGATOR: Ralph Mitchell, Battelle Columbus  
 PHONE: (614) 424-7441  
 PROJECT TITLE: Exposure Study for Workers in Electronic Components Manufacturing Industry  
 SPONSOR: NIOSH  
 FUNDING LEVEL: \$1,150,000 (?)  
 EFFECTIVE DATES: 1981-1983  
 DESCRIPTION: A pilot study was conducted in one home monitoring IAQ in the living room and kitchen. Nine workers in Portland, Maine were followed to assess total exposure during the summer of 1982 and the winter of 1982-1983. The following were monitored: SF<sub>6</sub> (tracer), NO, NO<sub>2</sub>, O<sub>3</sub>, SO<sub>2</sub>, THC, HCHO, RSP, BaP, Ra, CO, and approximately 10 additional compounds.

## CATEGORIZATION OF RESEARCH

|                             |                                    |                                                           |
|-----------------------------|------------------------------------|-----------------------------------------------------------|
| 1. <u>Study Type</u>        | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                                      |
| Laboratory <u>    </u>      | Characterization <u>  ✓  </u>      | CO <u>  ✓  </u> CO <sub>2</sub> <u>    </u>               |
| Field <u>  ✓  </u>          | Modeling <u>    </u>               | NO <sub>x</sub> <u>  ✓  </u> SO <sub>2</sub> <u>  ✓  </u> |
|                             | Monitoring <u>  ✓  </u>            | Radioactivity <u>  ✓  </u>                                |
|                             | Instrument Development <u>    </u> | Formaldehyde <u>  ✓  </u>                                 |
| 2. <u>Major Sources</u>     | Health Effects <u>    </u>         | Other organics <u>  ✓  </u>                               |
| <u>                    </u> | Risk Assessment <u>    </u>        | Asbestos or other fibers <u>    </u>                      |
| <u>                    </u> | Control Technology <u>  ✓  </u>    | Tobacco smoke <u>    </u>                                 |
| <u>                    </u> |                                    | Respirable particulates/TSP <u>  ✓  </u>                  |
| <u>                    </u> | 4. <u>Special Facilities</u>       | Odor <u>    </u>                                          |
| <u>                    </u> | Chamber <u>  ✓  </u>               | Ozone <u>  ✓  </u>                                        |
| <u>                    </u> | Research House <u>    </u>         | Airborne Biological <u>    </u>                           |
| <u>                    </u> | Other (Specify) <u>    </u>        | Multi-pollutant <u>  ✓  </u>                              |
| <u>                    </u> | <u>                    </u>        | Ventilation rate (tracer) <u>    </u>                     |
| <u>                    </u> | <u>                    </u>        | Metals <u>    </u>                                        |
| <u>                    </u> | <u>                    </u>        | Pesticides <u>    </u>                                    |
| <u>                    </u> | <u>                    </u>        | PCB's <u>    </u>                                         |
| <u>                    </u> | <u>                    </u>        | Other (Specify) <u>    </u>                               |

C29

## SUMMARY OF RESEARCH

INVESTIGATOR: J. Spengler, Harvard  
 PHONE: (617) 732-1255  
 PROJECT TITLE: Health Effects of Sulfur Oxides and Particulates  
 SPONSOR: NIEHS/EPRI  
 FUNDING LEVEL: \$500K/yr for first five yrs; \$1000K/yr for final four years  
 EFFECTIVE DATES: 7/74-8/83  
 DESCRIPTION: The goal is to evaluate the effects of low levels of SO<sub>2</sub> and RSP on the health of humans and to determine the degree of interaction of these pollutants. Six communities have been chosen with high, medium, and low levels of SO<sub>2</sub> and RSP. Random samples of the adult population have been selected for study. A cohort of children has been selected from each community and is being followed prospectively. Monitoring for SO<sub>2</sub>, RSP, and NO<sub>2</sub> is conducted indoors and outdoors.

## CATEGORIZATION OF RESEARCH

|                                           |                                                      |                                                                                                         |
|-------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                      | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                                                    |
| Laboratory <input type="checkbox"/>       | Characterization <input checked="" type="checkbox"/> | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>                                    |
| Field <input checked="" type="checkbox"/> | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input checked="" type="checkbox"/> |
|                                           | Monitoring <input checked="" type="checkbox"/>       | Radioactivity <input type="checkbox"/>                                                                  |
|                                           | Instrument Development <input type="checkbox"/>      | Formaldehyde <input type="checkbox"/>                                                                   |
| 2. <u>Major Sources</u>                   | Health Effects <input checked="" type="checkbox"/>   | Other organics <input type="checkbox"/>                                                                 |
| <input type="checkbox"/>                  | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                                       |
| <input type="checkbox"/>                  | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                                                  |
| <input type="checkbox"/>                  |                                                      | Respirable particulates/TSP <input checked="" type="checkbox"/>                                         |
| <input type="checkbox"/>                  | 4. <u>Special Facilities</u>                         | Odor <input type="checkbox"/>                                                                           |
| <input type="checkbox"/>                  | Chamber <input type="checkbox"/>                     | Ozone <input type="checkbox"/>                                                                          |
| <input type="checkbox"/>                  | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                                            |
| <input type="checkbox"/>                  | Other (Specify) <input type="checkbox"/>             | Multi-pollutant <input type="checkbox"/>                                                                |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | Ventilation rate (tracer) <input checked="" type="checkbox"/>                                           |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | Metals <input checked="" type="checkbox"/>                                                              |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | Pesticides <input type="checkbox"/>                                                                     |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | PCB's <input type="checkbox"/>                                                                          |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | Other (Specify) <input checked="" type="checkbox"/>                                                     |
|                                           |                                                      | Sulfate <input type="checkbox"/>                                                                        |

C30

## SUMMARY OF RESEARCH

INVESTIGATOR: J. Spengler, Harvard  
 PHONE: (617) 732-1255  
 PROJECT TITLE: Effects of SO<sub>2</sub> and Respirable Particulates on Health  
 SPONSOR: NIEHS/EPRI  
 FUNDING LEVEL: Approximately \$1,000,000/yr  
 EFFECTIVE DATES: 1983-1988  
 DESCRIPTION: This project is a continuation of the first (six communities) study. A new cohort of 1000 children will be identified in each of the cities and followed prospectively. The original cohort of young people will also be followed. Results will be analyzed to determine the differences in health effects associated with the different exposure of the two groups.

## CATEGORIZATION OF RESEARCH

|                             |                                 |                                                      |
|-----------------------------|---------------------------------|------------------------------------------------------|
| 1. <u>Study Type</u>        | 3. <u>Area</u>                  | 5. <u>Pollutants</u>                                 |
| Laboratory <u>    </u>      | Characterization <u>✓</u>       | CO <u>✓</u> CO <sub>2</sub> <u>✓</u>                 |
| Field <u>✓</u>              | Modeling <u>✓</u>               | NO <sub>x</sub> <u>✓</u> SO <sub>2</sub> <u>    </u> |
|                             | Monitoring <u>✓</u>             | Radioactivity <u>✓</u>                               |
|                             | Instrument Development <u>✓</u> | Formaldehyde <u>✓</u>                                |
| 2. <u>Major Sources</u>     | Health Effects <u>✓</u>         | Other organics <u>    </u>                           |
| <u>                    </u> | Risk Assessment <u>    </u>     | Asbestos or other fibers <u>    </u>                 |
| <u>                    </u> | Control Technology <u>    </u>  | Tobacco smoke <u>✓</u>                               |
| <u>                    </u> |                                 | Respirable particulates/TSP <u>✓</u>                 |
| <u>                    </u> | 4. <u>Special Facilities</u>    | Odor <u>    </u>                                     |
| <u>                    </u> | Chamber <u>    </u>             | Ozone <u>    </u>                                    |
| <u>                    </u> | Research House <u>    </u>      | Airborne Biological <u>    </u>                      |
| <u>                    </u> | Other (Specify) <u>    </u>     | Multi-pollutant <u>    </u>                          |
| <u>                    </u> | <u>                    </u>     | Ventilation rate (tracer) <u>✓</u>                   |
| <u>                    </u> | <u>                    </u>     | Metals <u>    </u>                                   |
| <u>                    </u> | <u>                    </u>     | Pesticides <u>    </u>                               |
| <u>                    </u> | <u>                    </u>     | PCB's <u>    </u>                                    |
| <u>                    </u> | <u>                    </u>     | Other (Specify) <u>✓</u>                             |
|                             |                                 | Humidity <u>    </u>                                 |

## SUMMARY OF RESEARCH

INVESTIGATOR: J. Spengler Harvard  
PHONE: (617) 732-1255  
PROJECT TITLE: Personal Exposure and Monitoring in the Home.  
SPONSOR: GRI  
FUNDING LEVEL: \$1,300,000  
EFFECTIVE DATES: 7/83-12/86  
DESCRIPTION: Protocol development and equipment specification currently underway. Current thinking--broad based study maybe 1000 homes. Identify homes for personal exposures, and identify homes for passive and continuous monitoring. Hope to be in the field by end of 1984.

### CATEGORIZATION OF RESEARCH

- | 1. Study Type                             | 3. Area                                        | 5. Pollutants                                                       |
|-------------------------------------------|------------------------------------------------|---------------------------------------------------------------------|
| Laboratory                                | Characterization                               | CO <input checked="" type="checkbox"/> CO <sub>2</sub>              |
| Field <input checked="" type="checkbox"/> | Modeling <input checked="" type="checkbox"/>   | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> |
|                                           | Monitoring <input checked="" type="checkbox"/> | Radioactivity                                                       |
|                                           | Instrument Development                         | Formaldehyde                                                        |
| 2. Major Sources                          | Health Effects                                 | Other organics                                                      |
|                                           | Risk Assessment                                | Asbestos or other fibers                                            |
|                                           | Control Technology                             | Tobacco smoke                                                       |
|                                           |                                                | Respirable particulates/TSP                                         |
|                                           | 4. Special Facilities                          | Odor                                                                |
|                                           | Chamber                                        | Ozone                                                               |
|                                           | Research House                                 | Airborne Biological                                                 |
|                                           | Other (Specify)                                | Multi-pollutant                                                     |
|                                           |                                                | Ventilation rate (tracer)                                           |
|                                           |                                                | Metals                                                              |
|                                           |                                                | Pesticides                                                          |
|                                           |                                                | PCB's                                                               |
|                                           |                                                | Other (Specify)                                                     |



## SUMMARY OF RESEARCH

INVESTIGATOR: B. P. Leaderer, J.B. Pierce Foundation  
 PHONE: (203) 562-9901  
 PROJECT TITLE: Emission Factors for Side Stream Tobacco Smoke  
 SPONSOR: NIEHS  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 7/82-7/85  
 DESCRIPTION: Organic and Inorganic Portion of Gaseous and Particulate Tobacco smoke will be studied.

## CATEGORIZATION OF RESEARCH

|                                                |                                                                                 |                                                                                   |
|------------------------------------------------|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                                                  | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>                            | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                                               | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                                             | Radioactivity <input type="checkbox"/>                                            |
|                                                | Instrument Development <input type="checkbox"/>                                 | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                                         | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>                                        | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                       | Control Technology <input type="checkbox"/>                                     | Tobacco smoke <input checked="" type="checkbox"/>                                 |
| <input type="checkbox"/>                       |                                                                                 | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                                                    | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                       | Chamber <input checked="" type="checkbox"/> *                                   | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | Research House <input checked="" type="checkbox"/> **                           | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                       | Other (Specify) <input checked="" type="checkbox"/>                             | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                       | Mobile monitors for residence                                                   | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <input type="checkbox"/>                       | (CO, CO <sub>2</sub> , O <sub>2</sub> , NO, NO <sub>2</sub> , SO <sub>2</sub> ) | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                       | Pollutant generation capabilities for laboratory                                | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                       | *1-34m <sup>3</sup> Al recirculation 0-100ACH                                   | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | Temp. 1-50° C ± 0.1° C; fresh air                                               | Other (Specify) <input type="checkbox"/>                                          |
| <input type="checkbox"/>                       | 0-20 ACH dew pt. 4-45° C ± 0.2° C                                               |                                                                                   |
|                                                | **3-thermal chambers for physiological research                                 |                                                                                   |

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## SUMMARY OF RESEARCH

INVESTIGATOR: A.J. Stolwijk, J.B. Pierce Foundation  
 PHONE: (203) 562-9901  
 PROJECT TITLE: Human Responses to the Indoor Environment (Program Project Grant)  
 SPONSOR: NIEHS  
 FUNDING LEVEL:  
 EFFECTIVE DATES:  
 DESCRIPTION: Four programs and directors given below:  
 Characterization of the Thermal Indoor Environment - L. Bergland  
 Human Responses to the Indoor Thermal Environment - R. Gonzales  
 Characterization and Modeling of Indoor Contaminants - B. Leaderer  
 Human Responses to Indoor Air Pollutants - W. Cain

## CATEGORIZATION OF RESEARCH

|                                     |                                                 |                                                                                   |
|-------------------------------------|-------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                | 3. <u>Area</u>                                  | 5. <u>Pollutants</u>                                                              |
| Laboratory <input type="checkbox"/> | Characterization <input type="checkbox"/>       | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>      | Modeling <input type="checkbox"/>               | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                     | Monitoring <input type="checkbox"/>             | Radioactivity <input type="checkbox"/>                                            |
|                                     | Instrument Development <input type="checkbox"/> | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>             | Health Effects <input type="checkbox"/>         | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>            | Risk Assessment <input type="checkbox"/>        | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>            | Control Technology <input type="checkbox"/>     | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>            |                                                 | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>            | 4. <u>Special Facilities</u>                    | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>            | Chamber <input type="checkbox"/>                | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>            | Research House <input type="checkbox"/>         | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>            | Other (Specify) <input type="checkbox"/>        | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>            | <input type="checkbox"/>                        | Other (Specify) <input type="checkbox"/>                                          |

C34

## SUMMARY OF RESEARCH

INVESTIGATOR: W. Cain and B. P. Leaderer, J.P. Pierce Foundation  
 PHONE: (203) 562-9901  
 PROJECT TITLE: Odor Experiments  
 SPONSOR: NIEHS  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 7/82-7/85  
 DESCRIPTION: Assess the required ventilation rates for smoking versus nonsmoking occupancy. Investigate efficacy of fabric filters, precipitators, and sorption beds.

## CATEGORIZATION OF RESEARCH

|                                                |                                                        |                                                                                   |
|------------------------------------------------|--------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                         | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>   | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                      | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                    | Radioactivity <input type="checkbox"/>                                            |
|                                                | Instrument Development <input type="checkbox"/>        | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>               | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                       | Control Technology <input checked="" type="checkbox"/> | Tobacco smoke <input checked="" type="checkbox"/>                                 |
| <input type="checkbox"/>                       |                                                        | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                           | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                       | Chamber <input checked="" type="checkbox"/>            | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | Research House <input type="checkbox"/>                | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                       | Other (Specify) <input type="checkbox"/>               | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | <input type="checkbox"/>                               | Other (Specify) <input type="checkbox"/>                                          |

C35

## SUMMARY OF RESEARCH

INVESTIGATOR: B.P. Leaderer, J.P. Pierce Foundation  
 PHONE: (203) 562-9901  
 PROJECT TITLE: Decay of SO<sub>2</sub> and NO<sub>2</sub> on Surfaces  
 SPONSOR: NIEHS  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 7/82-7/85  
 DESCRIPTION:

## CATEGORIZATION OF RESEARCH

|                                                |                                                      |                                                                                                         |
|------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                                                    |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/> | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>                                    |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input checked="" type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                  | Radioactivity <input type="checkbox"/>                                                                  |
|                                                | Instrument Development <input type="checkbox"/>      | Formaldehyde <input type="checkbox"/>                                                                   |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>              | Other organics <input type="checkbox"/>                                                                 |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                                       |
| <input type="checkbox"/>                       | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                                                  |
| <input type="checkbox"/>                       |                                                      | Respirable particulates/TSP <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                         | Odor <input type="checkbox"/>                                                                           |
| <input type="checkbox"/>                       | Chamber <input checked="" type="checkbox"/>          | Ozone <input type="checkbox"/>                                                                          |
| <input type="checkbox"/>                       | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                                            |
| <input type="checkbox"/>                       | Other (Specify) <input type="checkbox"/>             | Multi-pollutant <input type="checkbox"/>                                                                |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Ventilation rate (tracer) <input type="checkbox"/>                                                      |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Metals <input type="checkbox"/>                                                                         |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Pesticides <input type="checkbox"/>                                                                     |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | PCB's <input type="checkbox"/>                                                                          |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Other (Specify) <input type="checkbox"/>                                                                |

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## SUMMARY OF RESEARCH

INVESTIGATOR: B.P. Leaderer, J.B. Pierce Foundation  
 PHONE: (203) 562-9901  
 PROJECT TITLE: Comparison of Aerosol Monitors  
 SPONSOR: NIEHS  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 7/82-7/85  
 DESCRIPTION: The calibration of aerosol monitors compares several portable particulate monitors to filters measurements; the lab will examine particulate loss due to volatilization.

## CATEGORIZATION OF RESEARCH

|                                                |                                                            |                                                                                   |
|------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                             | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>       | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                          | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                        | Radioactivity <input type="checkbox"/>                                            |
|                                                | Instrument Development <input checked="" type="checkbox"/> | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                    | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>                   | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                       | Control Technology <input type="checkbox"/>                | Tobacco smoke <input checked="" type="checkbox"/>                                 |
| <input type="checkbox"/>                       |                                                            | Respirable particulates/TSP <input checked="" type="checkbox"/>                   |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                               | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                       | Chamber <input checked="" type="checkbox"/>                | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | Research House <input type="checkbox"/>                    | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                       | Other (Specify) <input type="checkbox"/>                   | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | Other (Specify) <input type="checkbox"/>                                          |



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## SUMMARY OF RESEARCH

INVESTIGATOR: W. Cain, J.B. Pierce Foundation  
 PHONE: (203) 562-9901  
 PROJECT TITLE: Formaldehyde Irritation to Humans  
 SPONSOR: NIEHS  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 7/82-7/85  
 DESCRIPTION: Investigate the irritation resulting from human exposure to formaldehyde (in chambers).

## CATEGORIZATION OF RESEARCH

|                                                |                                                      |                                                                                   |
|------------------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/> | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                  | Radioactivity <input type="checkbox"/>                                            |
|                                                | Instrument Development <input type="checkbox"/>      | Formaldehyde <input checked="" type="checkbox"/>                                  |
| 2. <u>Major Sources</u>                        | Health Effects <input checked="" type="checkbox"/>   | Other organics <input type="checkbox"/>                                           |
| <u>                    </u>                    | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                 |
| <u>                    </u>                    | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                            |
| <u>                    </u>                    |                                                      | Respirable particulates/TSP <input type="checkbox"/>                              |
| <u>                    </u>                    | 4. <u>Special Facilities</u>                         | Odor <input type="checkbox"/>                                                     |
| <u>                    </u>                    | Chamber <input checked="" type="checkbox"/>          | Ozone <input type="checkbox"/>                                                    |
| <u>                    </u>                    | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                      |
| <u>                    </u>                    | Other (Specify) <input type="checkbox"/>             | Multi-pollutant <input type="checkbox"/>                                          |
| <u>                    </u>                    | <u>                    </u>                          | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <u>                    </u>                    | <u>                    </u>                          | Metals <input type="checkbox"/>                                                   |
| <u>                    </u>                    | <u>                    </u>                          | Pesticides <input type="checkbox"/>                                               |
| <u>                    </u>                    | <u>                    </u>                          | PCB's <input type="checkbox"/>                                                    |
| <u>                    </u>                    | <u>                    </u>                          | Other (Specify) <input type="checkbox"/>                                          |

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## SUMMARY OF RESEARCH

INVESTIGATOR: J.A.J. Stolwijk and B.P. Leaderer, J.B. Pierce Foundation  
 PHONE: (203) 562-9901  
 PROJECT TITLE: Residential Exposures to NO<sub>2</sub>, SO<sub>2</sub> and Formaldehyde  
 SPONSOR:  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 10/82-6/84  
 DESCRIPTION: Unvented keorsene space heaters, gas appliances and side stream emissions from tobacco smoke were the subjects of an epidemiological study in 350 homes.

## CATEGORIZATION OF RESEARCH

|                             |                                    |                                                           |
|-----------------------------|------------------------------------|-----------------------------------------------------------|
| 1. <u>Study Type</u>        | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                                      |
| Laboratory <u>    </u>      | Characterization <u>  ✓  </u>      | CO <u>    </u> CO <sub>2</sub> <u>    </u>                |
| Field <u>  ✓  </u>          | Modeling <u>    </u>               | NO <sub>x</sub> <u>  ✓  </u> SO <sub>2</sub> <u>  ✓  </u> |
|                             | Monitoring <u>  ✓  </u>            | Radioactivity <u>    </u>                                 |
|                             | Instrument Development <u>    </u> | Formaldehyde <u>  ✓  </u>                                 |
| 2. <u>Major Sources</u>     | Health Effects <u>  ✓  </u>        | Other organics <u>  ✓  </u>                               |
| <u>                    </u> | Risk Assessment <u>    </u>        | Asbestos or other fibers <u>    </u>                      |
| <u>                    </u> | Control Technology <u>    </u>     | Tobacco smoke <u>    </u>                                 |
| <u>                    </u> |                                    | Respirable particulates/TSP <u>    </u>                   |
| <u>                    </u> | 4. <u>Special Facilities</u>       | Odor <u>    </u>                                          |
| <u>                    </u> | Chamber <u>    </u>                | Ozone <u>    </u>                                         |
| <u>                    </u> | Research House <u>    </u>         | Airborne Biological <u>    </u>                           |
| <u>                    </u> | Other (Specify) <u>    </u>        | Multi-pollutant <u>    </u>                               |
| <u>                    </u> | <u>                    </u>        | Ventilation rate (tracer) <u>    </u>                     |
| <u>                    </u> | <u>                    </u>        | Metals <u>    </u>                                        |
| <u>                    </u> | <u>                    </u>        | Pesticides <u>    </u>                                    |
| <u>                    </u> | <u>                    </u>        | PCB's <u>    </u>                                         |
| <u>                    </u> | <u>                    </u>        | Other (Specify) <u>    </u>                               |

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## SUMMARY OF RESEARCH

INVESTIGATOR: N. Schackter, J.B. Pierce Foundation  
 PHONE: (203) 562-9901  
 PROJECT TITLE: Human Response to SO<sub>2</sub>, NO<sub>2</sub> and Formaldehyde  
 SPONSOR:  
 FUNDING LEVEL:  
 EFFECTIVE DATES:  
 DESCRIPTION: Investigate the effects manifested by human subjects  
 exposed to SO<sub>2</sub>, NO<sub>2</sub>, and HCHO

## CATEGORIZATION OF RESEARCH

|                                                |                                                      |                                                                                                         |
|------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                                                    |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/> | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>                                    |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input checked="" type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                  | Radioactivity <input type="checkbox"/>                                                                  |
|                                                | Instrument Development <input type="checkbox"/>      | Formaldehyde <input checked="" type="checkbox"/>                                                        |
| 2. <u>Major Sources</u>                        | Health Effects <input checked="" type="checkbox"/>   | Other organics <input type="checkbox"/>                                                                 |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                                       |
| <input type="checkbox"/>                       | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                                                  |
| <input type="checkbox"/>                       |                                                      | Respirable particulates/TSP <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                         | Odor <input type="checkbox"/>                                                                           |
| <input type="checkbox"/>                       | Chamber <input checked="" type="checkbox"/>          | Ozone <input type="checkbox"/>                                                                          |
| <input type="checkbox"/>                       | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                                            |
| <input type="checkbox"/>                       | Other (Specify) <input type="checkbox"/>             | Multi-pollutant <input type="checkbox"/>                                                                |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Ventilation rate (tracer) <input type="checkbox"/>                                                      |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Metals <input type="checkbox"/>                                                                         |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Pesticides <input type="checkbox"/>                                                                     |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | PCB's <input type="checkbox"/>                                                                          |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Other (Specify) <input type="checkbox"/>                                                                |

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## SUMMARY OF RESEARCH

INVESTIGATOR: R. Maxwell, TVA  
 PHONE: (205) 386-2767  
 PROJECT TITLE: Background Study of Radioactivity in 60 Nonslag Homes  
 SPONSOR:  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1/84-1/85  
 DESCRIPTION: Phosphate slag, a byproduct from fertilizer, has naturally occurring radioactivity. This material has been used as a filler in some building materials. As a result, TVA conducted a 30 home survey of radioactivity levels in slag and nonslag homes in 1979. Results of this study have prompted the upcoming investigation into the variability of radioactivity in 60 nonslag homes.

## CATEGORIZATION OF RESEARCH

|                          |                                      |                                                             |
|--------------------------|--------------------------------------|-------------------------------------------------------------|
| 1. <u>Study Type</u>     | 3. <u>Area</u>                       | 5. <u>Pollutants</u>                                        |
| Laboratory <u>      </u> | Characterization <u>  ✓  </u>        | CO <u>      </u> CO <sub>2</sub> <u>      </u>              |
| Field <u>  ✓  </u>       | Modeling <u>      </u>               | NO <sub>x</sub> <u>      </u> SO <sub>2</sub> <u>      </u> |
|                          | Monitoring <u>  ✓  </u>              | Radioactivity <u>  ✓  </u>                                  |
|                          | Instrument Development <u>      </u> | Formaldehyde <u>      </u>                                  |
| 2. <u>Major Sources</u>  | Health Effects <u>      </u>         | Other organics <u>      </u>                                |
| <u>      </u>            | Risk Assessment <u>      </u>        | Asbestos or other fibers <u>      </u>                      |
| <u>      </u>            | Control Technology <u>      </u>     | Tobacco smoke <u>      </u>                                 |
| <u>      </u>            |                                      | Respirable particulates/TSP <u>      </u>                   |
| <u>      </u>            | 4. <u>Special Facilities</u>         | Odor <u>      </u>                                          |
| <u>      </u>            | Chamber <u>      </u>                | Ozone <u>      </u>                                         |
| <u>      </u>            | Research House <u>      </u>         | Airborne Biological <u>      </u>                           |
| <u>      </u>            | Other (Specify) <u>      </u>        | Multi-pollutant <u>      </u>                               |
| <u>      </u>            | <u>      </u>                        | Ventilation rate (tracer) <u>  ✓  </u>                      |
| <u>      </u>            | <u>      </u>                        | Metals <u>      </u>                                        |
| <u>      </u>            | <u>      </u>                        | Pesticides <u>      </u>                                    |
| <u>      </u>            | <u>      </u>                        | PCB's <u>      </u>                                         |
| <u>      </u>            | <u>      </u>                        | Other (Specify) <u>      </u>                               |

C41

## SUMMARY OF RESEARCH

INVESTIGATOR: R. Imhoff, TVA  
 PHONE: (205) 386-2788  
 PROJECT TITLE: Ambient Woodstove Emissions and Indoor Air Quality  
 SPONSOR: TVA/EPA (Biomass Integrated Environmental Assessment)  
 FUNDING LEVEL: \$20,000  
 EFFECTIVE DATES: 12/83-6/84  
 DESCRIPTION: The goal of this project will be to study the impact of a woodstove plume on the indoor air quality of an affected house. Two houses will be involved in this study. The study duration is expected to be two months.

## CATEGORIZATION OF RESEARCH

|                                           |                                                      |                                                                                   |
|-------------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. Study Type                             | 3. Area                                              | 5. Pollutants                                                                     |
| Laboratory <input type="checkbox"/>       | Characterization <input checked="" type="checkbox"/> | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input checked="" type="checkbox"/> | Modeling <input checked="" type="checkbox"/>         | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                           | Monitoring <input checked="" type="checkbox"/>       | Radioactivity <input type="checkbox"/>                                            |
|                                           | Instrument Development <input type="checkbox"/>      | Formaldehyde <input type="checkbox"/>                                             |
| 2. Major Sources                          | Health Effects <input type="checkbox"/>              | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                  | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                  | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>                  |                                                      | Respirable particulates/TSP <input checked="" type="checkbox"/>                   |
| <input type="checkbox"/>                  | 4. Special Facilities                                | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                  | Chamber <input type="checkbox"/>                     | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                  | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                  | Other (Specify) <input type="checkbox"/>             | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | Ventilation rate (tracer) <input checked="" type="checkbox"/>                     |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                  | <input type="checkbox"/>                             | Other (Specify) <input checked="" type="checkbox"/>                               |
|                                           |                                                      | Nephelometer <input type="checkbox"/>                                             |
|                                           |                                                      | Trace Elements <input type="checkbox"/>                                           |



## SUMMARY OF RESEARCH

INVESTIGATOR: J. Harper, TVA  
 PHONE: (615) 751-6887  
 PROJECT TITLE: Effects of Residential Woodburning Stoves on Indoor Air Quality  
 SPONSOR: TVA-BPA  
 FUNDING LEVEL: \$110,000  
 EFFECTIVE DATES: 1/83-3/83  
 DESCRIPTION: Four woodburning stoves were tested in a test house--2 catalytic and 2 noncatalytic stoves. The house has 1200 ft<sup>2</sup> and has 0.3 to 0.5 ach. The following were monitored: NO<sub>x</sub>, CO, CO<sub>2</sub>, TSP & RSP (both indoor and outdoors), and PAH's as well as other organics.

## CATEGORIZATION OF RESEARCH

|                             |                                    |                                                          |
|-----------------------------|------------------------------------|----------------------------------------------------------|
| 1. <u>Study Type</u>        | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                                     |
| Laboratory <u>    </u>      | Characterization <u>  ✓  </u>      | CO <u>  ✓  </u> CO <sub>2</sub> <u>  ✓  </u>             |
| Field <u>    </u>           | Modeling <u>  ✓  </u>              | NO <sub>x</sub> <u>  ✓  </u> SO <sub>2</sub> <u>    </u> |
|                             | Monitoring <u>  ✓  </u>            | Radioactivity <u>    </u>                                |
|                             | Instrument Development <u>    </u> | Formaldehyde <u>    </u>                                 |
| 2. <u>Major Sources</u>     | Health Effects <u>    </u>         | Other organics <u>  ✓  </u>                              |
| <u>2 noncatalytic</u>       | Risk Assessment <u>    </u>        | Asbestos or other                                        |
| <u>stoves</u>               | Control Technology <u>  ✓  </u>    | fibers <u>    </u>                                       |
| <u>2 catalytic stoves</u>   |                                    | Tobacco smoke <u>    </u>                                |
| <u>                    </u> |                                    | Respirable partic-                                       |
| <u>                    </u> | 4. <u>Special Facilities</u>       | ulates/TSP <u>  ✓  </u>                                  |
| <u>                    </u> | Chamber <u>    </u>                | Odor <u>    </u>                                         |
| <u>                    </u> | Research House <u>  ✓*  </u>       | Ozone <u>    </u>                                        |
| <u>                    </u> | Other (Specify) <u>    </u>        | Airborne Biological <u>    </u>                          |
| <u>                    </u> | <u>*4 test houses</u>              | Multi-pollutant <u>    </u>                              |
| <u>                    </u> | <u>                    </u>        | Ventilation rate                                         |
| <u>                    </u> | <u>                    </u>        | (tracer) <u>    </u>                                     |
| <u>                    </u> | <u>                    </u>        | Metals <u>    </u>                                       |
| <u>                    </u> | <u>                    </u>        | Pesticides <u>    </u>                                   |
| <u>                    </u> | <u>                    </u>        | PCB's <u>    </u>                                        |
|                             |                                    | Other (Specify) <u>    </u>                              |

## SUMMARY OF RESEARCH

## CATEGORIZATION OF RESEARCH

- 190

C44

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Moschandreas, IITRI  
 PHONE: (312) 567-4310  
 PROJECT TITLE: Odor Studies  
 SPONSOR: Varied  
 FUNDING LEVEL:  
 EFFECTIVE DATES:  
 DESCRIPTION: Studies of indoor air quality have been performed in response to complaints. The goal is usually to identify the source as well as the chemicals responsible.

## CATEGORIZATION OF RESEARCH

|                                     |                                                      |                                                                                   |
|-------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                              |
| Laboratory <input type="checkbox"/> | Characterization <input checked="" type="checkbox"/> | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>      | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                     | Monitoring <input type="checkbox"/>                  | Radioactivity <input type="checkbox"/>                                            |
|                                     | Instrument Development <input type="checkbox"/>      | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>             | Health Effects <input type="checkbox"/>              | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>            | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>            | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>            |                                                      | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>            | 4. <u>Special Facilities</u>                         | Odor <input checked="" type="checkbox"/>                                          |
| <input type="checkbox"/>            | Chamber <input type="checkbox"/>                     | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>            | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>            | Other (Specify) <input checked="" type="checkbox"/>  | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>            | <u>Sensory Laboratory (Odor panel)</u>               | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <input type="checkbox"/>            | <input type="checkbox"/>                             | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>            | <input type="checkbox"/>                             | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>            | <input type="checkbox"/>                             | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>            | <input type="checkbox"/>                             | Other (Specify) <input checked="" type="checkbox"/>                               |
|                                     |                                                      | <u>VOC</u>                                                                        |

C45

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Moschandreas, IITRI  
 PHONE: (312) 567-4310  
 PROJECT TITLE: Evaluation of Indoor Particulate Control Devices  
 SPONSOR: Industry Confidential  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1983-1984  
 DESCRIPTION:

## CATEGORIZATION OF RESEARCH

|                                                                                                                   |                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u><br>Laboratory <input checked="" type="checkbox"/><br>Field <input type="checkbox"/>          | 3. <u>Area</u><br>Characterization <input type="checkbox"/><br>Modeling <input type="checkbox"/><br>Monitoring <input type="checkbox"/><br>Instrument Development <input type="checkbox"/><br>Health Effects <input type="checkbox"/><br>Risk Assessment <input type="checkbox"/><br>Control Technology <input checked="" type="checkbox"/> | 5. <u>Pollutants</u><br>CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/><br>NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/><br>Radioactivity <input type="checkbox"/><br>Formaldehyde <input type="checkbox"/><br>Other organics <input type="checkbox"/><br>Asbestos or other fibers <input type="checkbox"/><br>Tobacco smoke <input type="checkbox"/><br>Respirable particulates/TSP <input checked="" type="checkbox"/><br>Odor <input type="checkbox"/><br>Ozone <input type="checkbox"/><br>Airborne Biological <input checked="" type="checkbox"/><br>Multi-pollutant <input type="checkbox"/><br>Ventilation rate (tracer) <input type="checkbox"/><br>Metals <input type="checkbox"/><br>Pesticides <input type="checkbox"/><br>PCB's <input type="checkbox"/><br>Other (Specify) <input checked="" type="checkbox"/><br><u>Smoke, Dust, Pollen</u> |
| 2. <u>Major Sources</u><br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____<br>_____ | 4. <u>Special Facilities</u><br>Chamber <input checked="" type="checkbox"/><br>Research House <input type="checkbox"/><br>Other (Specify) <input type="checkbox"/><br>_____<br>_____<br>_____<br>_____<br>_____                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

C46

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Moschandreas, IITRI  
 PHONE: (312) 567-4310  
 PROJECT TITLE: Woodstove Emissions of PAH  
 SPONSOR: Industry Confidential  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1983-1984  
 DESCRIPTION: Measurements will be conducted in 10 to 15 residences.

## CATEGORIZATION OF RESEARCH

|                          |                                     |                                                            |
|--------------------------|-------------------------------------|------------------------------------------------------------|
| 1. <u>Study Type</u>     | 3. <u>Area</u>                      | 5. <u>Pollutants</u>                                       |
| Laboratory <u>      </u> | Characterization <u>  ✓  </u>       | CO <u>  ✓  </u> CO <sub>2</sub> <u>      </u>              |
| Field <u>  ✓  </u>       | Modeling <u>      </u>              | NO <sub>x</sub> <u>  ✓  </u> SO <sub>2</sub> <u>      </u> |
|                          | Monitoring <u>  ✓  </u>             | Radioactivity <u>      </u>                                |
|                          | Instrument Development <u>  ✓  </u> | Formaldehyde <u>      </u>                                 |
| 2. <u>Major Sources</u>  | Health Effects <u>      </u>        | Other organics <u>      </u>                               |
| <u>      </u>            | Risk Assessment <u>      </u>       | Asbestos or other fibers <u>      </u>                     |
| <u>      </u>            | Control Technology <u>      </u>    | Tobacco smoke <u>      </u>                                |
| <u>      </u>            |                                     | Respirable particulates/TSP <u>      </u>                  |
| <u>      </u>            | 4. <u>Special Facilities</u>        | Odor <u>      </u>                                         |
| <u>      </u>            | Chamber <u>      </u>               | Ozone <u>      </u>                                        |
| <u>      </u>            | Research House <u>      </u>        | Airborne Biological <u>      </u>                          |
| <u>      </u>            | Other (Specify) <u>      </u>       | Multi-pollutant <u>      </u>                              |
| <u>      </u>            | <u>      </u>                       | Ventilation rate (tracer) <u>      </u>                    |
| <u>      </u>            | <u>      </u>                       | Metals <u>      </u>                                       |
| <u>      </u>            | <u>      </u>                       | Pesticides <u>      </u>                                   |
| <u>      </u>            | <u>      </u>                       | PCB's <u>      </u>                                        |
| <u>      </u>            | <u>      </u>                       | Other (Specify) <u>  ✓  </u>                               |
|                          |                                     | PAH <u>      </u>                                          |



C47

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Moschandreas, IITRI  
 PHONE: (312) 567-4310  
 PROJECT TITLE: Tracer Development  
 SPONSOR: Inhouse  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1983-1984  
 DESCRIPTION: To use perfluorocarbon tracer material to determine ventilation rates. Passive samplers will be used in conjunction with GC analysis.

## CATEGORIZATION OF RESEARCH

|                                                |                                                            |                                                                                   |
|------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                             | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input type="checkbox"/>                  | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                          | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input type="checkbox"/>                        | Radioactivity <input type="checkbox"/>                                            |
|                                                | Instrument Development <input checked="" type="checkbox"/> | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                    | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>                   | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                       | Control Technology <input type="checkbox"/>                | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>                       |                                                            | Respirable particulates/TSP <input type="checkbox"/>                              |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                               | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                       | Chamber <input checked="" type="checkbox"/>                | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | Research House <input type="checkbox"/>                    | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                       | Other (Specify) <input type="checkbox"/>                   | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | Ventilation rate (tracer) <input checked="" type="checkbox"/>                     |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | PCB's <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                   | Other (Specify) <input type="checkbox"/>                                          |

## SUMMARY OF RESEARCH

INVESTIGATOR: N.L. Nagda, Geomet  
 PHONE: (301) 424-9133  
 PROJECT TITLE: Exposure to CO  
 SPONSOR: EPRI  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 6/82-12/83  
 DESCRIPTION: The study goal was to characterize 24-hour exposure of three population subgroups to CO. Exposure was approximately 200 person days. CO levels in microenvironments were quantified and related to total exposure to housewives, office workers, and construction workers.

## CATEGORIZATION OF RESEARCH

|                             |                                    |                                                         |
|-----------------------------|------------------------------------|---------------------------------------------------------|
| 1. <u>Study Type</u>        | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                                    |
| Laboratory <u>    </u>      | Characterization <u>  ✓  </u>      | CO <u>  ✓  </u> CO <sub>2</sub> <u>    </u>             |
| Field <u>  ✓  </u>          | Modeling <u>    </u>               | NO <sub>x</sub> <u>    </u> SO <sub>2</sub> <u>    </u> |
|                             | Monitoring <u>  ✓  </u>            | Radioactivity <u>    </u>                               |
|                             | Instrument Development <u>    </u> | Formaldehyde <u>    </u>                                |
| 2. <u>Major Sources</u>     | Health Effects <u>    </u>         | Other organics <u>    </u>                              |
| <u>                    </u> | Risk Assessment <u>    </u>        | Asbestos or other                                       |
| <u>                    </u> | Control Technology <u>    </u>     | fibers <u>    </u>                                      |
| <u>                    </u> |                                    | Tobacco smoke <u>    </u>                               |
| <u>                    </u> |                                    | Respirable partic-                                      |
| <u>                    </u> | 4. <u>Special Facilities</u>       | ulates/TSP <u>    </u>                                  |
| <u>                    </u> | Chamber <u>    </u>                | Odor <u>    </u>                                        |
| <u>                    </u> | Research House <u>    </u>         | Ozone <u>    </u>                                       |
| <u>                    </u> | Other (Specify) <u>    </u>        | Airborne Biological <u>    </u>                         |
| <u>                    </u> | <u>                    </u>        | Multi-pollutant <u>    </u>                             |
| <u>                    </u> | <u>                    </u>        | Ventilation rate                                        |
| <u>                    </u> | <u>                    </u>        | (tracer) <u>    </u>                                    |
| <u>                    </u> | <u>                    </u>        | Metals <u>    </u>                                      |
| <u>                    </u> | <u>                    </u>        | Pesticides <u>    </u>                                  |
| <u>                    </u> | <u>                    </u>        | PCB's <u>    </u>                                       |
| <u>                    </u> | <u>                    </u>        | Other (Specify) <u>    </u>                             |

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## SUMMARY OF RESEARCH

INVESTIGATOR: N.L. Nagda, Geomet  
 PHONE: (301) 424-9133  
 PROJECT TITLE: Monitoring and Modeling of Energy Use, Infiltration, and IAQ  
 SPONSOR: EPRI  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 8/82-8/84  
 DESCRIPTION: A controlled study in two unoccupied identical single family homes simulates occupant activities. The goal is to describe the fundamental relationships between energy use, infiltration, and indoor air quality. Both single- and multiple-zone models are used. The following are monitored as a function of ambient conditions, season, heat exchange, and HVAC: CO, NO<sub>2</sub>, IP, RN, RN progeny, HCHO, SF<sub>6</sub> (tracer), and energy consumption.

## CATEGORIZATION OF RESEARCH

|                                                |                                                        |                                                                                              |
|------------------------------------------------|--------------------------------------------------------|----------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                         | 5. <u>Pollutants</u>                                                                         |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>   | CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input checked="" type="checkbox"/>      | Modeling <input checked="" type="checkbox"/>           | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input checked="" type="checkbox"/>         | Radioactivity <input checked="" type="checkbox"/>                                            |
|                                                | Instrument Development <input type="checkbox"/>        | Formaldehyde <input checked="" type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                | Other organics <input type="checkbox"/>                                                      |
| <u>Domestic</u>                                | Risk Assessment <input type="checkbox"/>               | Asbestos or other fibers <input type="checkbox"/>                                            |
| <u>Particle board</u>                          | Control Technology <input checked="" type="checkbox"/> | Tobacco smoke <input type="checkbox"/>                                                       |
| <u>Gas stove</u>                               |                                                        | Respirable particulates/TSP <input checked="" type="checkbox"/>                              |
| <u>Woodstove</u>                               | 4. <u>Special Facilities</u>                           | Odor <input type="checkbox"/>                                                                |
| <u>                    </u>                    | Chamber <input type="checkbox"/>                       | Ozone <input type="checkbox"/>                                                               |
| <u>                    </u>                    | Research House <input checked="" type="checkbox"/> *   | Airborne Biological <input type="checkbox"/>                                                 |
| <u>                    </u>                    | Other (Specify) <input checked="" type="checkbox"/>    | Multi-pollutant <input type="checkbox"/>                                                     |
| <u>                    </u>                    | Mobile Lab <input type="checkbox"/>                    | Ventilation rate <input checked="" type="checkbox"/>                                         |
| <u>                    </u>                    | *2-325 m <sup>3</sup> <input type="checkbox"/>         | (tracer) <input type="checkbox"/>                                                            |
| <u>                    </u>                    | <u>                    </u>                            | Metals <input type="checkbox"/>                                                              |
| <u>                    </u>                    | <u>                    </u>                            | Pesticides <input type="checkbox"/>                                                          |
| <u>                    </u>                    | <u>                    </u>                            | PCB's <input type="checkbox"/>                                                               |
|                                                |                                                        | Other (Specify) <input type="checkbox"/>                                                     |

C50

## SUMMARY OF RESEARCH

INVESTIGATOR: N.L. Nagda, Geomet  
 PHONE: (301) 424-9133  
 PROJECT TITLE: Exposure to Respirable Particulates  
 SPONSOR:  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 11/83-5/84  
 DESCRIPTION: Evaluate current techniques for measuring respirable particulates in microenvironments.

## CATEGORIZATION OF RESEARCH

|                                                |                                                                                        |                                                                                   |
|------------------------------------------------|----------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                                                         | 5. <u>Pollutants</u>                                                              |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input type="checkbox"/>                                              | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>              |
| Field <input checked="" type="checkbox"/>      | Modeling <input type="checkbox"/>                                                      | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                                | Monitoring <input checked="" type="checkbox"/>                                         | Radioactivity <input type="checkbox"/>                                            |
|                                                | Instrument Development <input checked="" type="checkbox"/>                             | Formaldehyde <input type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                                                | Other organics <input type="checkbox"/>                                           |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>                                               | Asbestos or other fibers <input type="checkbox"/>                                 |
| <input type="checkbox"/>                       | Control Technology <input type="checkbox"/>                                            | Tobacco smoke <input type="checkbox"/>                                            |
| <input type="checkbox"/>                       |                                                                                        | Respirable particulates/TSP <input checked="" type="checkbox"/>                   |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                                                           | Odor <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                       | Chamber <input type="checkbox"/>                                                       | Ozone <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | Research House <input checked="" type="checkbox"/>                                     | Airborne Biological <input type="checkbox"/>                                      |
| <input type="checkbox"/>                       | Other (Specify) <input checked="" type="checkbox"/>                                    | Multi-pollutant <input type="checkbox"/>                                          |
| <input type="checkbox"/>                       | Mobile Lab - Ra, Criteria Pollutant, SF <sub>6</sub> (tracer) <input type="checkbox"/> | Ventilation rate (tracer) <input type="checkbox"/>                                |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                                               | Metals <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                                               | Pesticides <input type="checkbox"/>                                               |
| <input type="checkbox"/>                       | <input type="checkbox"/>                                                               | PC3's <input type="checkbox"/>                                                    |
|                                                |                                                                                        | Other (Specify) <input type="checkbox"/>                                          |

C51

## SUMMARY OF RESEARCH

INVESTIGATOR: R.A. Wadden, School of Public Health, Univ. of Illinois  
 PHONE: (312) 996-0810  
 PROJECT TITLE: Indoor Air Pollution Research  
 SPONSOR: Inhouse  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1974-ongoing  
 DESCRIPTION: Historical work has been comprised of small projects conducted by graduate students. Professors Wadden and Scheff have taught an APCA-sponsored short course in Indoor Air Quality. Their recent book evolved from notes for that class.  
 (R.A. Wadden and P. Scheff. Indoor Air Pollution: Characterization Prediction and Control Wiley Interscience, 1983.)

## CATEGORIZATION OF RESEARCH

|                                                |                                                        |                                                                                                         |
|------------------------------------------------|--------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                         | 5. <u>Pollutants</u>                                                                                    |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/>   | CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input checked="" type="checkbox"/>              |
| Field <input checked="" type="checkbox"/>      | Modeling <input checked="" type="checkbox"/>           | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input checked="" type="checkbox"/> |
|                                                | Monitoring <input checked="" type="checkbox"/>         | Radioactivity <input type="checkbox"/>                                                                  |
|                                                | Instrument Development <input type="checkbox"/>        | Formaldehyde <input checked="" type="checkbox"/>                                                        |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>                | Other organics <input checked="" type="checkbox"/>                                                      |
| _____                                          | Risk Assessment <input type="checkbox"/>               | Asbestos or other fibers <input type="checkbox"/>                                                       |
| _____                                          | Control Technology <input checked="" type="checkbox"/> | Tobacco smoke <input checked="" type="checkbox"/>                                                       |
| _____                                          |                                                        | Respirable particulates/TSP <input checked="" type="checkbox"/>                                         |
| _____                                          | 4. <u>Special Facilities</u>                           | Odor <input type="checkbox"/>                                                                           |
| _____                                          | Chamber <input type="checkbox"/>                       | Ozone <input checked="" type="checkbox"/>                                                               |
| _____                                          | Research House <input type="checkbox"/>                | Airborne Biological <input checked="" type="checkbox"/>                                                 |
| _____                                          | Other (Specify) <input checked="" type="checkbox"/>    | Multi-pollutant <input type="checkbox"/>                                                                |
| _____                                          | EAA, CNC, Nebulizers <input type="checkbox"/>          | Ventilation rate (tracer) <input checked="" type="checkbox"/>                                           |
| _____                                          | Standard measurement systems <input type="checkbox"/>  | Metals <input type="checkbox"/>                                                                         |
| _____                                          | _____                                                  | Pesticides <input type="checkbox"/>                                                                     |
| _____                                          | _____                                                  | PCB's <input type="checkbox"/>                                                                          |
| _____                                          | _____                                                  | Other (Specify) <input type="checkbox"/>                                                                |



C52

## SUMMARY OF RESEARCH

INVESTIGATOR: D. Zerba, Pacific Power and Light  
 PHONE: (503) 243-4876  
 PROJECT TITLE: Residential Ventilation  
 SPONSOR: PPL (Battelle Northwest is main contractor)  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1980-1985  
 DESCRIPTION: The main goal is to study ventilation rate in three field houses located in Oregon. The houses range from 1100 to 1500 ft<sup>2</sup>; one is conventional; one is energy conserving; and one is a control. The study will last for two years with outdoor meteorological parameters, indoor temperature, and ventilation rate monitored. The houses will be modified for the second year: house 1 will be weatherized; house 2 will have an air to air heat exchanger; and house 3 will go from unoccupied to occupied.

## CATEGORIZATION OF RESEARCH

|                         |                                    |                                                         |
|-------------------------|------------------------------------|---------------------------------------------------------|
| 1. <u>Study Type</u>    | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                                    |
| Laboratory <u>    </u>  | Characterization <u>  ✓  </u>      | CO <u>    </u> CO <sub>2</sub> <u>    </u>              |
| Field <u>  ✓  </u>      | Modeling <u>    </u>               | NO <sub>x</sub> <u>    </u> SO <sub>2</sub> <u>    </u> |
|                         | Monitoring <u>  ✓  </u>            | Radioactivity <u>    </u>                               |
|                         | Instrument Development <u>    </u> | Formaldehyde <u>    </u>                                |
| 2. <u>Major Sources</u> | Health Effects <u>    </u>         | Other organics <u>    </u>                              |
| <u>    </u>             | Risk Assessment <u>    </u>        | Asbestos or other fibers <u>    </u>                    |
| <u>    </u>             | Control Technology <u>    </u>     | Tobacco smoke <u>    </u>                               |
| <u>    </u>             |                                    | Respirable particulates/TSP <u>    </u>                 |
| <u>    </u>             | 4. <u>Special Facilities</u>       | Odor <u>    </u>                                        |
| <u>    </u>             | Chamber <u>    </u>                | Ozone <u>    </u>                                       |
| <u>    </u>             | Research House <u>    </u>         | Airborne Biological <u>    </u>                         |
| <u>    </u>             | Other (Specify) <u>    </u>        | Multi-pollutant <u>    </u>                             |
| <u>    </u>             | <u>    </u>                        | Ventilation rate (tracer) <u>  ✓  </u>                  |
| <u>    </u>             | <u>    </u>                        | Metals <u>    </u>                                      |
| <u>    </u>             | <u>    </u>                        | Pesticides <u>    </u>                                  |
| <u>    </u>             | <u>    </u>                        | PCB's <u>    </u>                                       |
| <u>    </u>             | <u>    </u>                        | Other (Specify) <u>    </u>                             |
|                         |                                    | <u>    </u>                                             |

C53

## SUMMARY OF RESEARCH

INVESTIGATOR: J. Quackenboss, University of Wisconsin  
 PHONE: (608) 263-6928  
 PROJECT TITLE: Weatherization and Indoor Air Quality Study  
 SPONSOR: Wisconsin Power & Light/cooperation with Harvard Univ.  
 FUNDING LEVEL: \$224,000  
 EFFECTIVE DATES: 8/82-7/84  
 DESCRIPTION: Indoor Air Quality is being examined on 50 homes in South Central Wisconsin before and after weatherization. Each home will be sampled 7 times. Seasonal variability will be addressed. Wisconsin Power and Light will determine the extent of retrofit. Passive and active samplers will be involved. An acute symptoms checklist will be maintained by each participant. Questionnaires designed to describe homes, activities and gas equipment use will be employed.

## CATEGORIZATION OF RESEARCH

|                             |                                    |                                                          |
|-----------------------------|------------------------------------|----------------------------------------------------------|
| 1. <u>Study Type</u>        | 3. <u>Area</u>                     | 5. <u>Pollutants</u>                                     |
| Laboratory <u>    </u>      | Characterization <u>  ✓  </u>      | CO <u>  ✓  </u> CO <sub>2</sub> <u>  ✓  </u>             |
| Field <u>  ✓  </u>          | Modeling <u>  ✓  </u>              | NO <sub>x</sub> <u>  ✓  </u> SO <sub>2</sub> <u>    </u> |
|                             | Monitoring <u>  ✓  </u>            | Radioactivity <u>  ✓  </u>                               |
|                             | Instrument Development <u>    </u> | Formaldehyde <u>  ✓  </u>                                |
| 2. <u>Major Sources</u>     | Health Effects <u>  ✓  </u>        | Other organics <u>  ✓  </u>                              |
| <u>                    </u> | Risk Assessment <u>  ✓  </u>       | Asbestos or other fibers <u>    </u>                     |
| <u>                    </u> | Control Technology <u>    </u>     | Tobacco smoke <u>    </u>                                |
| <u>                    </u> |                                    | Respirable particulates/TSP <u>  ✓  </u>                 |
| <u>                    </u> | 4. <u>Special Facilities</u>       | Odor <u>    </u>                                         |
| <u>                    </u> | Chamber <u>    </u>                | Ozone <u>    </u>                                        |
| <u>                    </u> | Research House <u>    </u>         | Airborne Biological <u>    </u>                          |
| <u>                    </u> | Other (Specify) <u>  ✓  </u>       | Multi-pollutant <u>    </u>                              |
| <u>                    </u> | Monitoring Module <u>    </u>      | Ventilation rate (tracer) <u>  ✓  </u>                   |
| <u>                    </u> | <u>                    </u>        | Metals <u>    </u>                                       |
| <u>                    </u> | <u>                    </u>        | Pesticides <u>    </u>                                   |
| <u>                    </u> | <u>                    </u>        | PCB's <u>    </u>                                        |
| <u>                    </u> | <u>                    </u>        | Other (Specify) <u>    </u>                              |

C54

## SUMMARY OF RESEARCH

INVESTIGATOR: K. Jones, R.F. Weston  
 PHONE: (215) 692-3030  
 PROJECT TITLE: Indoor Air Quality Study Related to the Use of Kerosene Space Heaters  
 SPONSOR: National Kerosene Heaters Association and Kerosun  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1/83-3/83  
 DESCRIPTION: A one month intensive monitoring effort was conducted in a single-family residence to collect data on emissions from a radiant and a convective kerosene heater. Extensive instrumentation including dosimeters and active and passive monitors were employed. The results were evaluated with respect to pollutant exposure and to validate a multi-compartment indoor air quality model.

## CATEGORIZATION OF RESEARCH

|                         |                                     |                                                           |
|-------------------------|-------------------------------------|-----------------------------------------------------------|
| 1. <u>Study Type</u>    | 3. <u>Area</u>                      | 5. <u>Pollutants</u>                                      |
| Laboratory <u>    </u>  | Characterization <u>  ✓  </u>       | CO <u>  ✓  </u> CO <sub>2</sub> <u>  ✓  </u>              |
| Field <u>  ✓  </u>      | Modeling <u>  ✓  </u>               | NO <sub>x</sub> <u>  ✓  </u> SO <sub>2</sub> <u>  ✓  </u> |
|                         | Monitoring <u>  ✓  </u>             | Radioactivity <u>    </u>                                 |
|                         | Instrument Development <u>  ✓  </u> | Formaldehyde <u>    </u>                                  |
| 2. <u>Major Sources</u> | Health Effects <u>    </u>          | Other organics <u>    </u>                                |
| <u>Kerosene heaters</u> | Risk Assessment <u>    </u>         | Asbestos or other fibers <u>    </u>                      |
| <u>    </u>             | Control Technology <u>  ✓  </u>     | Tobacco smoke <u>    </u>                                 |
| <u>    </u>             |                                     | Respirable particulates/TSP <u>  ✓  </u>                  |
| <u>    </u>             | 4. <u>Special Facilities</u>        | Odor <u>    </u>                                          |
| <u>    </u>             | Chamber <u>    </u>                 | Ozone <u>    </u>                                         |
| <u>    </u>             | Research House <u>    </u>          | Airborne Biological <u>    </u>                           |
| <u>    </u>             | Other (Specify) <u>  ✓  </u>        | Multi-pollutant <u>    </u>                               |
| <u>    </u>             | Mobile GC/MS <u>    </u>            | Ventilation rate (tracer) <u>  ✓  </u>                    |
| <u>    </u>             | <u>    </u>                         | Metals <u>    </u>                                        |
| <u>    </u>             | <u>    </u>                         | Pesticides <u>    </u>                                    |
| <u>    </u>             | <u>    </u>                         | PCB's <u>    </u>                                         |
| <u>    </u>             | <u>    </u>                         | Other (Specify) <u>  ✓  </u>                              |
| <u>    </u>             | <u>    </u>                         | O <sub>2</sub> <u>    </u>                                |

C55

## SUMMARY OF RESEARCH

INVESTIGATOR: G. Adams, Niagara Mohawk  
 PHONE: (315) 428-6657  
 PROJECT TITLE: Residential and Commercial Indoor Air Quality  
 SPONSOR: Niagara Mohawk and NYERDA; Contractor W.S. Fleming  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1/82-12/84  
 DESCRIPTION: Approximately 40 homes were initially monitored for Ra, CO, CO<sub>2</sub>, NO<sub>2</sub>, HCHO, and RSP, primarily using passive monitors. Five homes have selected for more intensive continuous monitoring.

## CATEGORIZATION OF RESEARCH

|                                           |                                                      |                                                                                              |
|-------------------------------------------|------------------------------------------------------|----------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                      | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                                         |
| Laboratory <input type="checkbox"/>       | Characterization <input checked="" type="checkbox"/> | CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input checked="" type="checkbox"/>   |
| Field <input checked="" type="checkbox"/> | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                           | Monitoring <input checked="" type="checkbox"/>       | Radioactivity <input checked="" type="checkbox"/>                                            |
|                                           | Instrument Development <input type="checkbox"/>      | Formaldehyde <input checked="" type="checkbox"/>                                             |
| 2. <u>Major Sources</u>                   | Health Effects <input type="checkbox"/>              | Other organics <input type="checkbox"/>                                                      |
| _____                                     | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                            |
| _____                                     | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                                       |
| _____                                     |                                                      | Respirable particulates/TSP <input checked="" type="checkbox"/>                              |
| _____                                     | 4. <u>Special Facilities</u>                         | Odor <input type="checkbox"/>                                                                |
| _____                                     | Chamber <input type="checkbox"/>                     | Ozone <input type="checkbox"/>                                                               |
| _____                                     | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                                 |
| _____                                     | Other (Specify) <input type="checkbox"/>             | Multi-pollutant <input type="checkbox"/>                                                     |
| _____                                     | _____                                                | Ventilation rate (tracer) <input type="checkbox"/>                                           |
| _____                                     | _____                                                | Metals <input type="checkbox"/>                                                              |
| _____                                     | _____                                                | Pesticides <input type="checkbox"/>                                                          |
| _____                                     | _____                                                | PCB's <input type="checkbox"/>                                                               |
| _____                                     | _____                                                | Other (Specify) <input type="checkbox"/>                                                     |

C56

## SUMMARY OF RESEARCH

INVESTIGATOR: John Yocum, TRC  
 PHONE: (203) 289-8631  
 PROJECT TITLE: Evaluation of Indoor Air Quality Data for Making Risk Assessments  
 SPONSOR: EPRI  
 FUNDING LEVEL:  
 EFFECTIVE DATES: 1982-1983  
 DESCRIPTION: Available information on NO<sub>2</sub>, Rn, Tobacco Smoke, and HCHO was examined. Reported results on health effects, exposure, air exchange, pollutant levels, decay, and modeling were examined to determine if a risk assessment can be performed. This work was a cooperative effort between TRC and Harvard. Results suggest that it is unlikely existing data can support a risk assessment.

## CATEGORIZATION OF RESEARCH

|                                     |                                                     |                                                                                              |
|-------------------------------------|-----------------------------------------------------|----------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                | 3. <u>Area</u>                                      | 5. <u>Pollutants</u>                                                                         |
| Laboratory <input type="checkbox"/> | Characterization <input type="checkbox"/>           | CO <input type="checkbox"/> CO <sub>2</sub> <input type="checkbox"/>                         |
| Field <input type="checkbox"/>      | Modeling <input type="checkbox"/>                   | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/> |
|                                     | Monitoring <input type="checkbox"/>                 | Radioactivity <input checked="" type="checkbox"/>                                            |
|                                     | Instrument Development <input type="checkbox"/>     | Formaldehyde <input checked="" type="checkbox"/>                                             |
| 2. <u>Major Sources</u>             | Health Effects <input type="checkbox"/>             | Other organics <input type="checkbox"/>                                                      |
| <input type="checkbox"/>            | Risk Assessment <input checked="" type="checkbox"/> | Asbestos or other fibers <input type="checkbox"/>                                            |
| <input type="checkbox"/>            | Control Technology <input type="checkbox"/>         | Tobacco smoke <input checked="" type="checkbox"/>                                            |
| <input type="checkbox"/>            |                                                     | Respirable particulates/TSP <input type="checkbox"/>                                         |
| <input type="checkbox"/>            | 4. <u>Special Facilities</u>                        | Odor <input type="checkbox"/>                                                                |
| <input type="checkbox"/>            | Chamber <input type="checkbox"/>                    | Ozone <input type="checkbox"/>                                                               |
| <input type="checkbox"/>            | Research House <input type="checkbox"/>             | Airborne Biological <input type="checkbox"/>                                                 |
| <input type="checkbox"/>            | Other (Specify) <input type="checkbox"/>            | Multi-pollutant <input type="checkbox"/>                                                     |
| <input type="checkbox"/>            | <input type="checkbox"/>                            | Ventilation rate (tracer) <input type="checkbox"/>                                           |
| <input type="checkbox"/>            | <input type="checkbox"/>                            | Metals <input type="checkbox"/>                                                              |
| <input type="checkbox"/>            | <input type="checkbox"/>                            | Pesticides <input type="checkbox"/>                                                          |
| <input type="checkbox"/>            | <input type="checkbox"/>                            | PCB's <input type="checkbox"/>                                                               |
| <input type="checkbox"/>            | <input type="checkbox"/>                            | Other (Specify) <input type="checkbox"/>                                                     |



C57

## SUMMARY OF RESEARCH

INVESTIGATOR: John Yocum, TRC  
 PHONE: (203) 289-8631  
 PROJECT TITLE: IAQ Work at TRC  
 SPONSOR:  
 FUNDING LEVEL:  
 EFFECTIVE DATES:  
 DESCRIPTION:

Representative work that has been performed at TRC: characterize emissions from office machines, kerosene heaters, gas stoves, and other combustion sources; did first IAQ work; studied indoor-outdoor relationships; and use a mobile real time mass spectrometer (Trace Atmospheric Gas Analyzer, TAGA) to identify chemical responsible for various "sick building" compliants.

## CATEGORIZATION OF RESEARCH

|                                                |                                                      |                                                                                                         |
|------------------------------------------------|------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                                                    |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/> | CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input checked="" type="checkbox"/>              |
| Field <input checked="" type="checkbox"/>      | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input checked="" type="checkbox"/> SO <sub>2</sub> <input checked="" type="checkbox"/> |
|                                                | Monitoring <input checked="" type="checkbox"/>       | Radioactivity <input type="checkbox"/>                                                                  |
|                                                | Instrument Development <input type="checkbox"/>      | Formaldehyde <input checked="" type="checkbox"/>                                                        |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>              | Other organics <input type="checkbox"/>                                                                 |
| _____                                          | Risk Assessment <input checked="" type="checkbox"/>  | Asbestos or other fibers <input checked="" type="checkbox"/>                                            |
| _____                                          | Control Technology <input type="checkbox"/>          | Tobacco smoke <input checked="" type="checkbox"/>                                                       |
| _____                                          |                                                      | Respirable particulates/TSP <input checked="" type="checkbox"/>                                         |
| _____                                          | 4. <u>Special Facilities</u>                         | Odor <input checked="" type="checkbox"/>                                                                |
| _____                                          | Chamber <input type="checkbox"/>                     | Ozone <input checked="" type="checkbox"/>                                                               |
| _____                                          | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                                            |
| _____                                          | Other (Specify) <input checked="" type="checkbox"/>  | Multi-pollutant <input type="checkbox"/>                                                                |
| _____                                          | TAGA; Standards Lab; Odor Lab                        | Ventilation rate (tracer) <input checked="" type="checkbox"/>                                           |
| _____                                          | _____                                                | Metals <input type="checkbox"/>                                                                         |
| _____                                          | _____                                                | Pesticides <input type="checkbox"/>                                                                     |
| _____                                          | _____                                                | PCB's <input type="checkbox"/>                                                                          |
| _____                                          | _____                                                | Other (Specify) <input type="checkbox"/>                                                                |
|                                                |                                                      | _____                                                                                                   |

C58

## SUMMARY OF RESEARCH

INVESTIGATOR: Enno Toomsalu, Underwriters Lab., Inc.  
 PHONE: (312) 272-8800  
 PROJECT TITLE: Kerosene Heater Certification  
 SPONSOR: Various Manufacturer  
 FUNDING LEVEL:  
 EFFECTIVE DATES: Ongoing  
 DESCRIPTION: Duct kerosene heat emissions and sample exhaust measurements.  
 Hundreds of units were tested, and about 90% comply with UL647.

## CATEGORIZATION OF RESEARCH

|                                                |                                                      |                                                                                            |
|------------------------------------------------|------------------------------------------------------|--------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                                       |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/> | CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input checked="" type="checkbox"/> |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/>          |
|                                                | Monitoring <input type="checkbox"/>                  | Radioactivity <input type="checkbox"/>                                                     |
|                                                | Instrument Development <input type="checkbox"/>      | Formaldehyde <input type="checkbox"/>                                                      |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>              | Other organics <input type="checkbox"/>                                                    |
| <input type="checkbox"/>                       | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                          |
| <input type="checkbox"/>                       | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                                     |
| <input type="checkbox"/>                       |                                                      | Respirable particulates/TSP <input type="checkbox"/>                                       |
| <input type="checkbox"/>                       | 4. <u>Special Facilities</u>                         | Odor <input type="checkbox"/>                                                              |
| <input type="checkbox"/>                       | Chamber <input type="checkbox"/>                     | Ozone <input type="checkbox"/>                                                             |
| <input type="checkbox"/>                       | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                               |
| <input type="checkbox"/>                       | Other (Specify) <input checked="" type="checkbox"/>  | Multi-pollutant <input type="checkbox"/>                                                   |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Ventilation rate (tracer) <input type="checkbox"/>                                         |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Metals <input type="checkbox"/>                                                            |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Pesticides <input type="checkbox"/>                                                        |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | PCB's <input type="checkbox"/>                                                             |
| <input type="checkbox"/>                       | <input type="checkbox"/>                             | Other (Specify) <input type="checkbox"/>                                                   |

C59

## SUMMARY OF RESEARCH

INVESTIGATOR: Warren Porter, CPSC  
 PHONE: (301) 245-1445  
 PROJECT TITLE: Evaluation of Kerosene Heater Emissions  
 SPONSOR: CPSC  
 FUNDING LEVEL:  
 EFFECTIVE DATES: Ongoing  
 DESCRIPTION: Kerosene heaters were placed in 25 cubic meter test chambers.

## CATEGORIZATION OF RESEARCH

## 1. Study Type

Laboratory ☒  
 Field ☐

## 2. Major Sources

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## 3. Area

Characterization ☒  
 Modeling ☐  
 Monitoring ☐  
 Instrument Development ☐  
 Health Effects ☐  
 Risk Assessment ☐  
 Control Technology ☐

## 4. Special Facilities

Chamber ☒  
 Research House ☐  
 Other (Specify) ☐  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

## 5. Pollutants

CO ☒ CO<sub>2</sub> ☒  
 NO<sub>x</sub> ☒ SO<sub>2</sub> ☒  
 Radioactivity ☐  
 Formaldehyde ☐  
 Other organics ☒  
 Asbestos or other fibers ☐  
 Tobacco smoke ☐  
 Respirable particulates/TSP ☐  
 Odor ☐  
 Ozone ☐  
 Airborne Biological ☐  
 Multi-pollutant ☐  
 Ventilation rate (tracer) ☐  
 Metals ☐  
 Pesticides ☐  
 PCB's ☐  
 Other (Specify) ☐

C60

## SUMMARY OF RESEARCH

INVESTIGATOR: Kathy Blair, PFS Corporation  
 PHONE: (608) 221-3361  
 PROJECT TITLE: Kerosene Heater Certification  
 SPONSOR: Various Manufacturer  
 FUNDING LEVEL:  
 EFFECTIVE DATES: Ongoing  
 DESCRIPTION: Duct kerosene heat emissions and sample exhaust measurements. Acceptable units are listed with PFS and carry a seal of approval.

## CATEGORIZATION OF RESEARCH

|                                                |                                                      |                                                                                            |
|------------------------------------------------|------------------------------------------------------|--------------------------------------------------------------------------------------------|
| 1. <u>Study Type</u>                           | 3. <u>Area</u>                                       | 5. <u>Pollutants</u>                                                                       |
| Laboratory <input checked="" type="checkbox"/> | Characterization <input checked="" type="checkbox"/> | CO <input checked="" type="checkbox"/> CO <sub>2</sub> <input checked="" type="checkbox"/> |
| Field <input type="checkbox"/>                 | Modeling <input type="checkbox"/>                    | NO <sub>x</sub> <input type="checkbox"/> SO <sub>2</sub> <input type="checkbox"/>          |
|                                                | Monitoring <input type="checkbox"/>                  | Radioactivity <input type="checkbox"/>                                                     |
|                                                | Instrument Development <input type="checkbox"/>      | Formaldehyde <input type="checkbox"/>                                                      |
| 2. <u>Major Sources</u>                        | Health Effects <input type="checkbox"/>              | Other organics <input type="checkbox"/>                                                    |
| _____                                          | Risk Assessment <input type="checkbox"/>             | Asbestos or other fibers <input type="checkbox"/>                                          |
| _____                                          | Control Technology <input type="checkbox"/>          | Tobacco smoke <input type="checkbox"/>                                                     |
| _____                                          |                                                      | Respirable particulates/TSP <input type="checkbox"/>                                       |
| _____                                          | 4. <u>Special Facilities</u>                         | Odor <input type="checkbox"/>                                                              |
| _____                                          | Chamber <input checked="" type="checkbox"/>          | Ozone <input type="checkbox"/>                                                             |
| _____                                          | Research House <input type="checkbox"/>              | Airborne Biological <input type="checkbox"/>                                               |
| _____                                          | Other (Specify) <input type="checkbox"/>             | Multi-pollutant <input type="checkbox"/>                                                   |
| _____                                          | _____                                                | Ventilation rate (tracer) <input type="checkbox"/>                                         |
| _____                                          | _____                                                | Metals <input type="checkbox"/>                                                            |
| _____                                          | _____                                                | Pesticides <input type="checkbox"/>                                                        |
| _____                                          | _____                                                | PCB's <input type="checkbox"/>                                                             |
| _____                                          | _____                                                | Other (Specify) <input type="checkbox"/>                                                   |
|                                                |                                                      | _____                                                                                      |